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玉米、大蒭草及其雜交種之分蘗性、再生能力與一些重要農藝性狀之研究[1]

謝光照　盧煌勝[2]

摘要：臺灣牧草生產，夏季充裕而多季不足，如何善用種原以育成可供多季生產之青割玉米品種，是值得研究的課題。本試驗以一年生大蒭草 TeA (*Euchlaena mexicana,* 2n＝20)，多年生大蒭草 TeP (*Zea diploperennis,* 2n＝20)、玉米自交系 B77 (*Zea mays,* 2n＝20) 及其雜交種爲材料，進行分蘗性及再生能力等農藝性狀之探討。結果顯示，在秋作環境下，TeA 比 TeP 有較多之早期分蘗數，而在抽穗期之分蘗數則相近；主莖上著生雌穗之節數，TeA 及 TeP 均比B77多；出土後60天之乾物重及出土後30天之作物生長速率 (crop growth rate, CGR) 均以TeA最大，其次爲 B77，最小者爲TeP。B77 × TeA 及 B77 ×TeP 均比 TeA 或 TeP 具有較少之分蘗數，且主莖上著生雌穗之節數也較少；雜交種比其兩親本具有較大的乾物重及 CGR。TeA × TeP 之早期分蘗數及主莖節數均比親本多，且較親本晚開花及吐絲，出土後60天之乾物重及出土後30天之 CGR 表現則較親本差。吐絲期青割後之再生能力，親本以 TeP 最高，其次爲 TeA，B77 則無再生力；雜交種再生力的表現，以 TeA×TeP 最好，其次爲 B77×TeP，而 B77×TeA 並無任何再生芽出現。

關鍵詞：玉米、大蒭草、再生力。

玉米爲最優良的青割飼料作物之一，隨著畜牧事業的發展，其用途及需要與日俱增。正常環境下，栽培種玉米品種並不分蘗，且於營養生長期收割後，復生能力極弱。大蒭草可分爲：(1)一年生大蒭草 (Annual, *Euchlaena mexicana,* 2n＝20)，(2)多年生四倍體大蒭草 (Perennial tetraploid, *Zea perennis,* 2n＝40)，(3)多年生二倍體大蒭草 (Perennial diploid, *Zea diploperennis,* 2n＝20)。一年生大蒭草是玉米的近緣物種，其生長似野生或半野生雜草，原產於 Mexico 及 Guatemala[9,17]。Paulis and Wall[12]及 Ilits and Doebley[7]更進一步指出，一年生二倍體大蒭草是玉米的祖先。比較一年生與多年生大蒭草，顯示一年生大蒭草具有較強健的生育特性，直立，多分蘗，植株高大，莖稈較粗，葉片較寬長，雄穗花序大且分枝多，具短日性，必須在13小時的短日下經30天才開花[3,8]。

大蒭草因其分蘗頗多，且刈割後能復生，故爲一重要青刈型牧草，但缺點爲初期生長緩慢。一年生大蒭草、多年生大蒭草與玉米雜交均可結實產生後代[4,5,11,18]；多年生大蒭草與玉米之雜交種，其植株之生長特性介於兩親之間，通常基部會長出分蘗芽，呈現較弱之多年生性[5]，雜交種植株刈割後之再生能力稍弱，開花習性變爲不定日照型[15]。大蒭草子粒內具有重要之抗蟲成分甲硫

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胺酸（methionine）含量較玉米高出二倍[10]，因此，經由雜交或可將大蜀草之抗蟲性、多年生及多分蘗等優良特性與玉米之高產因子相結合，以利發展新的青割或青貯作物品種。

本試驗之目的即在瞭解玉米、一年生與多年生大蜀草及其雜交種之生育特性，以便作爲遺傳研究及育種改良上之參考。

材料與方法

本試驗所使用的材料有栽培種玉米自交系 B77、一年生大蜀草 TeA（*Euchlaena mexicana*, 2n＝20）、多年生大蜀草 TeP（*Zea diploperennis*, 2n＝20）及其相互間之雜交種等共計有六個參試品系。B77 分離自 W. L. Brown Pioneer 2-ear Composite，屬早熟馬齒種。1991年 9 月19日播種於農試所試驗田，田間採逢機完全區集設計，三行區、四重複，行長5.5m，行株距爲 75×20cm，兩粒播，出土後二週間苗，每穴僅留一株。基肥以台肥39號複合肥料（N：P_2O_5：K_2O＝12：18：12）每公頃施500kg，於播種前施入播種溝內，澆水後再播種。追肥於播種後 2 個月，以硫酸銨（N＝21%）每公頃施450kg。生育期間於10月23日及11月 8 日各灌水一次。所調查之性狀包括早期分蘗數、抽穗期分蘗數、開花期、吐絲期、主莖著生雌穗之節數、主莖總節數、乾物重及作物生長速率。各項性狀之調查方法如下：

1. 早期分蘗數（tillers at early stage-TES）：於出土後 4 週，每小區逢機選20株，調查單株之分蘗數，以平均值表示之。
2. 抽穗期分蘗數（tillers at tasseling stage-TTS）：於主莖抽穗期，每小區逢機選20株，調查其總分蘗數，以平均值表示之。
3. 開花期（days to tasseling-DTT）：小區中有50%以上植株之主莖達雄穗開花時所需之天數。
4. 吐絲期（days to silking-DTS）：小區中有50%以上植株之主莖達雌穗吐絲時所需之天數。
5. 主莖著生雌穗之節數（no. of ear-bearing-node at main stalk-EBNMS）：每小區逢機選20株，調查其植株主莖上著生雌穗的節位之數目。
6. 主莖總節數（no. of node at main stalk-NMS）：每小區逢機選20株，調查其植株地表面以上主莖之總節數。
7. 乾物重（dry weight-DW）：於出土後60天，每小區逢機割取10株，置於70°C之烘乾機中烘七天，再稱其乾重，以 g 表示。
8. 作物生長速率（crop growth rate-CGR）：由出土後30天之乾物重換算爲單株每天之乾物重增加速率，以 g/plant-day 表示。

所得之數據進行變方分析及平均值顯著性比較，同時計算平均雜種優勢率（heterosis, H_1）及雜種潛勢率（heterobeltiosis, H_2），$H_1=(F_1-\overline{MP})/\overline{MP}\times100$，$H_2=(F_1-HP)/HP\times100$ F_1 爲雜交種，$\overline{MP}$爲兩親本平均值，HP 爲較高親本值[6]。

結果與討論

大蜀草是玉米的近緣物種，與栽培種玉米在植株外型上有明顯差別[17]。本研究中之觀察結果，幼苗期的玉米葉片較大，植株較粗壯，生長亦較快速；大蜀草幼苗細瘦苗條，葉片狹小，類似雜草，但具有分蘗性。至開花期的成株而言，玉米雄穗呈一大串，具有一至二個雌穗，果穗較大；大蜀草多分蘗，每一分蘗芽會產生一個雄穗，花序較小，大部份節位均具有雌穗，屬多穗型，果穗外型爲單子粒成串併連。相對於多年生大蜀草，一年生大蜀草具有較強健的生育特性，其植株直立，多分蘗，高大且莖稈較粗，葉片寬且長，雄花序大而多分支，具短日性，在臺中地區每年僅在10月中旬左右開花，開花結實後於11月底即開始枯死，無越冬能力，一般僅能以種子繁殖。多年生大蜀草之植株矮小，分蘗性稍弱，莖稈更細，

葉片也較細長，花序小，對日照不敏感，整年皆可開花及吐絲，可以利用切莖、分株、種子及芽繁殖，並具有越冬能力，在此之觀察所得與成等[1]及 Iltis et al.[8]等之研究結果類似。

出土後六星期，一年生大芻草、玉米及其雜交種外觀上即有明顯差異存在，一年生大芻草之分蘗數最多；玉米自交系 B77 則沒有分蘗芽；其雜交種具有一個主莖及2～3個分蘗芽，生長較旺盛，抽穗亦早（圖 1），此結果與 Sheng[15]於1974年之發現相同。多年生大芻草、玉米及其雜交種之外觀亦明顯不同，多年生大芻草植株莖稈較細且分蘗芽多；而雜交種僅具有少數（3—4）個分蘗芽，生長較親本高大，外形介於兩親本之間，開花吐絲較早（圖 2）。一年生大芻草、多年生大芻草及其雜交種間作一比較，可看出一年生大芻草生長較旺盛，分蘗芽之莖稈較粗，葉片較大；而多年生大芻草則稍細小，兩者之雜交種生長較二親本差，外觀上與多年生大芻草較相近（圖 3）。

自交系 B77、一年生大芻草 TeA、多年生大芻草 TeP 及其相互間之雜交種之試驗數據經變方分析結果列於表 1，顯示所有調查之八個性狀在品系間均有極顯著之差異。表 2 列有玉米、大芻草及其雜種之八個性狀之平均值，就早期的分蘗數而言，TeA×TeP 及 TeA 最多；其次爲 TeP、B77×TeA 及 B77×TeP 三個表現相近（2.25～2.12）；而玉米並沒有分蘗性。隨著生育推進到開花期，TeA、TeP 及 TeA×TeP 之分蘗數均近於 5 上下；B77×TeA 及 B77×TeP 仍維持其初期之2.3－2.4之間；B77 仍無任何分蘗芽產生。開花及吐絲所需的日數趨勢一致，參試品系中，以 B77 最長；其次爲 TeA×TeP、TeA 及 TeP；B77×TeA 及 B77×TeP 均屬較早開花吐絲者。主莖上著生雌穗之節位數目，B77 僅有 1 個；TeA 及 TeA×TeP 則分別有6.08及6.38個；TeP、B77×TeA 及 B77×TeP 亦屬多穗型。主莖的節數，在品系間差異較不懸殊，14節以上的計有 B77、TeA、B77×TeA 及 B77×TeP；TeP 最少，僅有12.07節。乾物重以 B77×TeA 及 B77×TeP 最突出；B77 及 TeA 介於574—609之間；TeP 及 TeA×TeP 則相對的小了許多。B77×TeA 之 CGR 遠大於其他品系；TeP 及 TeA×TeP 之 CGR 值則甚小（0.71～0.73）。

圖 1. 玉米 B77，一年生大芻草 TeA 及其雜交種在出土後六星期之生長情形

Fig. 1. The plants of B77, TeA and their hybrid (at six weeks after emergence).

圖 2. 玉米 B77，多年生大芻草 TeP 及其雜交種在出土後六星期之生長情形

Fig. 2. The plants of B77, TeP and their hybrid (at six weeks after emergence).

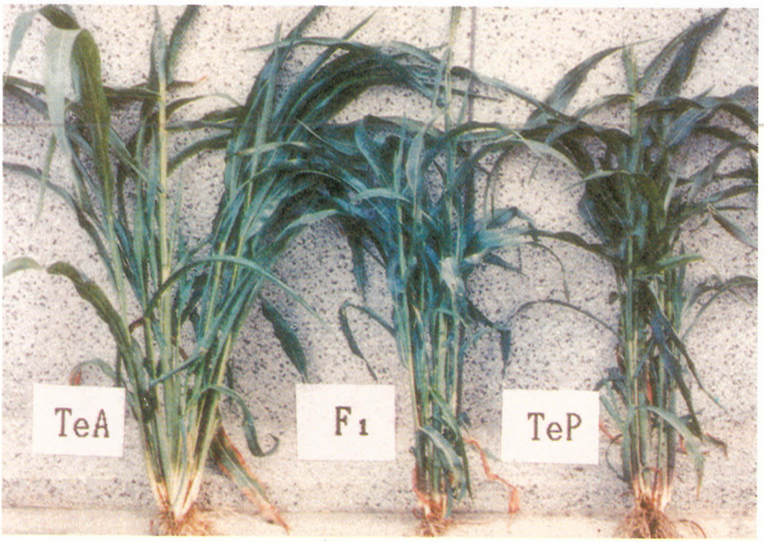

圖 3. 一年生大芻草 TeA，多年生大芻草 TeP 及其雜交種在出土後六星期之生長情形
Fig. 3. The plants of TeA, TeP and their hybrid (at six weeks after emergence).

表 1. 1991年秋作八個性狀之均方值
Table 1. Mean squares of eight traits measured in fall of 1991.

SOV	DF	TES	TTS	DTT	DTS	EBNMS	NMS	DW	CGR
Block	3	0.54	0.39	0.22	0.71	0.04	1.04*	1,641*	0.03*
Entry	5	6.00**	16.82**	84.20**	125.78**	15.66**	4.40**	27,358**	2.36**
Error	15	0.22	0.42	0.56	2.51	0.11	0.29	403	0.01

*, ** Significant at 5% and 1% levels, respectively.

表 2. 玉米、大芻草及其雜交種八個性狀之平均值
Table 2. Mean of eight traits for maize, teosinte and their hybrids.

Entry		TES (no./plant)	TTS (no./plant)	DTT (day)	DTS (day)	EBNMS (no./plant)	NMS (no./plant)	DW (g/10-plant)	CGR (g/plant day)
B77		0	0	55.25	59.75	1.00	14.85	574	0.96
TeA		3.02	5.21	48.75	52.75	6.38	14.15	609	1.02
TeP		2.25	4.95	45.00	49.25	5.63	12.07	439	0.73
B77×TeA		2.12	2.40	44.75	46.00	5.42	14.05	1,566	2.65
B77×TeP		2.25	2.32	42.25	44.75	4.82	13.52	1,088	1.81
TeA×TeP		3.60	4.82	49.00	54.25	6.08	14.92	426	0.71
LSD	(0.05)	0.70	0.98	1.12	2.38	0.50	0.81	96	0.14
	(0.01)	0.97	1.35	1.55	3.30	0.69	1.12	132	0.20

綜合各性狀之表現，可看出 B77×TeA 及 B77×TeP 較大芻草親本具有較少的分櫱數，較早開花及吐絲，主莖上著生雌穗之節位亦少了許多，而作物生長速率及乾物重則遠較親本大。TeA×TeP 在早期的分櫱數較親本略多，而抽穗期之分櫱數則反而較兩親本少，此或與生育期間部份分櫱芽退化死亡有關[2,16]。TeA×TeP 之開花期及吐絲期較兩親本晚；主莖上含有雌穗之節位稍少於 TeA，但卻顯著多於 TeP；主莖之節數較親本多；而乾物重及 CGR 則較 TeA大，但比 TeP 小。以上初步觀察顯示，栽培種玉米、一年生大芻草及多年生大芻草間各性狀之遺傳方式並非十分一致。

另由雜種優勢率觀之（表3），三個雜交種之平均雜種優勢率，早期分櫱數均爲正值，而抽穗期之分櫱數均爲負值。開花期及吐絲期之表現，在 B77×TeA 及 B77×TeP 爲負值，雜交種較親本有提早開花及吐絲之趨勢；而 TeA×TeP 則顯示具延遲開花之正值。主莖上著生雌穗之節位的雜種優勢均爲正值，其中以 B77×TeA 最大， TeA×TeP 爲最小。主莖之總節數B77×TeA 爲負值，而 B77×TeP 及 TeA×TeP 爲正值。CGR 及乾物重方面，B77×TeA 與 B77×TeP 爲正值，TeA×TeP 爲負值。Frankel[6]指出，由平均雜種優勢率、雜種潛勢率與顯性度之關係，可判斷部份顯性、顯性或超顯性對該性狀雜種優勢所扮演角色的重要性，由表3數值得知，早期之分櫱數在 B77×TeA 爲部份顯性，而 B77×TeP 爲顯性遺傳，TeA×TeP 則爲超顯性。抽穗期的分櫱數、開花期、吐絲期、乾物重及作物生長速率的表現則三個雜交組合均爲超顯性，而主莖上著生雌穗之節數則均爲部份顯性。主莖上之總節數在 B77×TeA 及 TeA×TeP 爲超顯性遺傳因子所控制，而在 B77×TeP 爲部份顯性。Sehgal[14]認爲玉米分櫱性的遺傳控制可能會受到大芻草豐富的分櫱性所影響；Rood and Major[13]的報告中也指出，玉米植株分櫱數之增加主要由累加性均方所控制，亦即呈現的爲部份顯性；本試驗結果則顯示，除 B77×TeA 在早期分櫱數、B77×TeP 之主莖總節數及三個組合之主莖著生雌穗之節數爲部份顯性外，其餘各組合之性狀表現則均爲顯性或超顯性，此間之差異或與試驗材料及試驗環境之不同有關，此點有待進一步探討。

表 3. 玉米與大芻草雜交種八個性狀之雜種優勢率（H1，%）[y] 及雜種潛勢率（H2，%）[z]

Table 3. Heterosis (H1，%)[y] and heterobeltiosis (H2，%)[z] for eight traits of maize×teosinte.

Entry		TES	TTS	DTT	DTS	EBNMS	NMS	DW	CGR
B77×TeA	H_1^y	40.4	−7.9	−13.9	−18.2	46.9	−3.1	164.7	168.5
	H_2^z	−29.8	−53.9	−19.0	−23.0	−15.0	−5.4	157.1	160.9
B77×TeP	H_1	100.0	−6.3	−15.7	−17.9	31.2	4.5	114.8	114.5
	H_2	0	−53.1	−23.5	−25.1	−14.3	−8.9	89.5	89.4
TeA×TeP	H_1	36.6	−5.1	4.5	6.3	1.2	13.8	−18.7	−18.6
	H_2	60.0	−7.5	0.5	2.8	−4.7	5.4	−30.0	−29.9
SE	H_1	42.1	1.4	11.2	14.0	23.2	8.5	94.8	85.4
	H_2	49.0	26.6	12.8	15.5	5.7	7.5	74.5	96.4

[y] $H_1\ (\%) = (\bar{F}_1-\overline{MP})/\overline{MP}$
[z] $H_2\ (\%) = (\bar{F}_1-HP)/HP$

出土後60天，由土表進行青割取樣，並於青割後三星期再調查其再生能力，結果顯示玉米自交系 B77 完全沒有再生能力；一年生大芻草 TeA 僅有極少植株出現再生芽，且芽長得很小；多年生大芻草 TeP 大部份植株均有再生芽出現，且單株的再生芽數較多。雜交種方面，B77×TeP 僅少部

份植株出現再生芽，而 B77×TeA 則無任何再生芽出現，此與 Sheng[15]之結果稍有不同，此與大芻草對光照敏感（短日性），以致秋作期間溫度又低或有關係。另外，此期間之營養生長期短，復於開花吐絲期後即進行取樣，對於重要農藝性狀如乾物重、CGR 及其再生與分櫱等性狀也有某種程度之不良影響。

臺灣牧草生產，在夏季充裕而冬季不足之情況下，如何利用玉米及大芻草種源，育成冬季生長旺盛之青飼料作物，是很重要的課題。一年生大芻草子粒內所含抗蟲之重要成分甲硫胺酸（methionine）比玉米高出二倍，而其色胺酸（tryptophane）及離胺酸（lysine）的含量與玉米則無明顯差異[10]；多年生大芻草，具備有多年生及多分櫱性，與玉米雜交產生之雜交種，其植株生長旺盛，且可結實[11]。本研究於秋冬季試驗中，部分玉米與一年生大芻草及多年生大芻草間之雜交種的生長勢、再生能力及抗病蟲性表現都還不錯將來進行青割玉米品質、產量及對逆境適應性改良工作，利用玉米、一年生大芻草及多年生大芻草間優良特性之相互轉移，或許也是一個頗具潛力之發展途徑。

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Studies on the Tillering, Ratoon Ability and Some Agronomic Characteristics in Maize, Teosinte and Their Hybrids[1]

Guang-Jauh Shieh and Hung-Shung Lu[2]

Summary

Aunual teosinte TeA (*Euchlaena mexicana* 2n=20), perennial diploid teosinte TeP (*Zea diploperennis,* 2n=20), maize inbred line B77 (*Zea mays,* 2n=20) and their hybrids were used to investigate the inheritance of tillering, ratoon ability and other agronomic characteristics. The results are summaried as follows: TeA had more early stage tillers than TeP, but had similar tiller number at tasseling stage in fall cropping season. The number of ear-bearing-node on the main stalk of B77 was less than that of teosinte. The dry weight measured at 60 days after emergence and crop growth rate (CGR) measured at 30 days after emergence were larger in TeA, while those of TeP were smaller. The tiller number and the number of ear-bearing-node on the main stalk of B77×TeA and B77×TeP were less than those of TeA and TeP, but B77×TeA and B77×TeP had more dry weight and CGR than their parents. TeA×TeP had less CGR and dry weight than their parents. TeP had better ratoon ability following by TeA, while B77 was unable to regrow after being cut in the silking stage. TeA×TeP hybrid had larger ratoon ability following by B77×TeP, but B77×TeA had no ratoon ability.

Key words : Maize (*Zea mays*), Teosinte (*Euchlaena mexicana* and *Zea diploperennis*), Ratoon ability.

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黃耆類藥材之鑑定研究

I. 膜莢黃耆、蒙古黃耆與多序岩黃耆之辨僞[1]

林郁進[2]　張永勳[2]　蔡新聲[3]

摘要：黃耆（Astragali Radix）著錄於神農本草經，並沿用迄今重要藥材之一。黃耆別名極多且來源植物混雜，極易影響藥材規格與臨床療效之評估，故應以「黃耆」爲正名，「膜莢黃耆（*Astragalus membranaceus*（Fisch.）Bunge var. *membranaceus*）」或「蒙古黃耆〔*A. membranaceus*（Fisch.）Bunge var. *mongholicus*（Bunge）P. K. Hsiao〕爲主要來源植物。與膜莢黃耆比較時，蒙古黃耆植株較矮小，小葉數多，葉面積小且先端較鈍圓，莢果上光滑無毛，主根長但較細，縱皺紋明顯，石細胞較小，原生木部不呈角星形；臺灣習用之紅耆，主要來源植物是多序岩黃耆（*Hedysarum polybotrys* Hand.-Mazz.），與膜莢黃耆比較時，多序岩黃耆之小葉數少，莢果上有莢節呈連珠狀、成熟後不開裂，種子僅1枚，根皮紅棕色或紅褐色、甜度大，原生木部不呈角星形，無石細胞，但有結晶纖維及大量草酸鈣結晶等，分類特徵與膜莢黃耆或蒙古黃耆截然不同，故應區別使用。

關鍵詞：膜莢黃耆、蒙古黃耆、多序岩黃耆、組織鑑定。

黃耆著錄於神農本草經，列爲草部上品，以後歷代諸家本草皆有收載與增著，並沿用迄今重要藥材之一，臨床上用量極大。本經云：「黃耆，主癰疽久敗瘡、排膿止痛、大風癩疾、五痔鼠瘻、補虛、小兒百病」[17]，且黃耆生用固表、無汗能發、有汗能止，炙用補中益元氣、溫三焦、壯脾胃、生血生肌、排膿內托、癰瘡聖藥，痘症不起、陽虛無熱者宜之，故而被奉爲「補氣諸藥之最」[24]，現代藥理學實驗亦證明黃耆具有抗衰老、增強免疫功能、利尿與降壓等作用[7,5,8,9,25,32,40]。

黃耆名稱極多，如載糝[17]，百本、芰草[10]，黃芪或黃蓍[11]等，十分混亂，莫衷一是，且因歷代之黃耆產地更替頻繁[15,18,19,29]，致黃耆類藥材之來源十分複雜，大陸地區習以膜莢黃耆〔*Astragalus membranaceus*（Fisch.）Bunge var. *membranaceus*〕或蒙古黃耆〔*A. membranaceus*（Fisch.）Bunge. var. *mongholicus*（Bunge）P. K. Hsiao.〕爲黃耆類藥材之主要來源植物[6]，其餘種類則列爲地區代用品或僞品[3,21,27,35,36]，雖有多位學者致力於黃耆屬植物之生藥學研究[16,21,22,26,27,34]，但中國產豆科（Leguminosae）黃耆屬（*Astragalus*）植物有300餘種[2]，且入藥用爲黃耆藥材者超過25種，復因僞品充斥，市場品中常出現之苜蓿屬、草木樨屬與野百合屬植物之根，甚至錦葵科植物都曾經混雜入藥用，僞稱黃耆[15,22]，使黃耆藥材之品質始終無法穩定與規格化。

臺灣地區習用之紅耆，或稱晉耆，係採挖岩黃耆屬（*Hedysarum*）多序岩黃耆（*Hedysarum polybotrys* Hand.-Mazz.）植物之新鮮根搓製而成[36]。黃耆（包括膜莢黃耆及蒙古黃耆）與多序岩

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黃耆是豆科不同屬植物，組織特徵、有效成分與臨床療效不盡相同，如黃耆之主要藥理活性成分 astragaloside IV，並未在紅耆中發現，且膜莢黃耆之 CANA/ARG（L-canavanine/L-arginine）值超過1.5倍，而紅耆卻低於0.1[26,31]，故二者關係應予釐清。

爲穩定及規範黃耆類藥材之品質，有必要正本清源，故首先進行黃耆之歷代本草學考察，了解黃耆類藥材之歷代變遷，探索黃耆之正名，同時了解其來源植物與多序岩黃耆植物之關係，並逐一鑑別，建立較完整生藥組織圖以供黃耆屬或其它科屬植物鑑定研究之比對，祈對黃耆類藥材之基原鑑定、品質規格、藥理活性與臨床療效評估等，提供基原鑑定等基礎研究之參考。

材料與方法

一、材　料

本研究材料膜莢黃耆於83年採自甘肅省宕昌縣海拔2,000公尺之向陽山坡，蒙古黃耆採自陝西省耀縣海拔1,800公尺之栽培區，多序岩黃耆採自甘肅省宕昌縣海拔2,100公尺之向陽山坡，經比對中國植物誌[2]與甘肅省蘭州醫學院中草藥研究所蠟葉標本室標本，並經該所中草藥耆宿趙志禮教授鑑定，確定其學名爲膜莢黃耆〔*Astragalus membranaceus*（Fisch.）Bunge var. *membranaceus*〕、蒙古黃耆〔*A. membranaceus*（Fisch.）Bunge. var. *mongholicus*（Bunge）P. K. Hsiao.〕及多序岩黃耆（*Hedysarum polybotrys* Hand.-Mazz.)後，並將三種材料之新鮮根攜回臺灣，種植於中國醫藥學院中國藥學研究所生藥研究室及植物生長箱中，每三天澆水一次，二個月後開花並有果莢形成，各剪取其中一株之花、果、枝葉及根製成蠟葉標本並照相留存後，部分根段經自然乾燥，儲放於 5°C之冰箱中備用。

二、方　法

1. 根之外部形質鑑別：利用五官鑑別法配合立體顯微鏡檢查。
2. 根之內部組織鑑別：分別截取膜莢黃耆、蒙古黃耆與多序岩黃耆直徑約 1cm之新鮮根爲材料，利用徒手切片法將材料進行橫切、放射性縱切及切線性縱切等，切取約10μm 之薄片檢體置於載玻片上，先以 chlorahydrate solution 清除細胞內含物後，再滴加各種不同化學染色劑如 phloroglucinol-alcohol 溶液與濃鹽酸進行木化反應，或滴加 SudanIII進行木栓化反應等，最後以 Glycerin:Water＝1：1 混合溶液將檢體封鎖，蓋上蓋玻片置於顯微鏡（Nikon, Photograp T-2）下，先以顯微鏡之低倍鏡頭檢查其輪廓，再轉換高倍鏡頭觀察各部分組織之特徵，並以顯微測微計（Micrometer, Nikon）量測各組織或細胞之大小，同時利用顯微攝影技術將各個觀察結果照相。
3. 根之粉末鑑別：分別截取膜莢黃耆、蒙古黃耆與多序岩黃耆長約 1 公分根段，以小刀剁碎並置烘箱中，在45°C下乾燥後，利用打粉機將材料研成粗粉，或以化學試劑（如50%KOH）將各個組織解離，並滴加上述之染色劑、碘化鉀溶液或 Million's reagent等化學試劑於材料中，進行顯微鏡定性檢查。

結　果

一、黃耆之藥名沿革

歷代諸家本草中記載黃耆之名稱甚多，如本經名載糁[17]，別錄稱載椹、獨椹、蜀脂、百本、芰草[10]，藥性論稱王孫，南海藥譜稱百藥綿[19]等，不一而論，其他地方性名稱更不勝枚舉，明朝李時珍之本草綱目又列錄黃芪[11]，今大陸地區即沿用黃芪之名[6]，另書寫黃蓍[11]者衆多，故黃耆習用名稱十分混亂。

二、黃耆類藥材之來源植物

漢朝陶弘景指出：「黃耆，第一出隴西、洮陽，色黃白，甜美。」[10]，此乃本草中最早記載黃耆產地與品質之敍述，隴西及洮陽應是今日四川省與陝西省耀縣、白水縣與南鄭縣一帶[10,30]，且後蜀以前，黃耆產地以甘肅東部、南部與陝西中部爲主，唐朝至明朝時期，改以陝西與山西省爲主，偶用甘肅所產，著名之綿黃耆即產於今日之山西省，至清朝吳其濬則說明山西與蒙古所產黃耆藥材之質地最好[13,14]，民國以後，黃耆之主產區則移往山西省渾源縣、東北大興安嶺與黑龍江[13,25]。

如以上本草之記載，黃耆藥材之主產地，由我國中西部之四川、甘肅、陝西、山西，迄今逐漸移往東北之大興安嶺與黑龍江一帶，產地變化幅度極大，其中是否伴隨植物種類更替，已不易查考，僅能就本草中寥寥數語之記載加以剖析，諸如「色黃白，甜美」[10]、「根長二三尺，獨莖或叢生枝幹，去地二三寸。其葉扶疏，作羊齒狀，又如蒺藜苗。七月開黃紫花，其實作莢，子長寸許。八月中採根，用其皮，折之如綿」[19]及「葉似蒺藜葉，闊大而青白色。開黃紫花，如槐花大。結小尖角，長寸許。」[19]等植物特徵，約略可發現極類似今日膜莢黃耆或蒙古黃耆植物（表１，圖１～４），但與多序岩黃耆植物之特徵比較，則截然不同（圖３，圖５），且「黃耆，有赤色者，可作膏貼用，消癰腫，俗方多用，道家不須。」[10]，顯見當時之赤色耆是民間或地區性用藥，且是外用製劑，與黃耆比較如南轅北轍，差距極大。

三、膜莢黃耆、蒙古黃耆與多序岩黃耆原植物之分類特徵

膜莢黃耆（*A. membranaceus* var. *membranaceus*）爲黃耆亞屬〔Subgen. *Phaca*（Linn.）Bunge〕膜莢組（Sect. *Cenantrum* Koch）之多年生草本植物[2]。如圖１所示，株高60～200cm，主根深長，長可達100～150cm，棒狀，偶有少數側根，稍帶木質。莖直立或斜生，單莖或２～５莖叢生，上部多分枝，光滑或疏被長柔毛。奇數羽狀複葉，互生，長５～10cm，葉柄長0.5～1cm；托葉離生，卵形、披針形或線狀披針形，長４～10cm，葉被無毛或疏被白柔毛；小葉對生，13～27片，橢圓形，長圓狀卵形，長７～30mm，寬３～12mm，基部圓形，先端鈍圓或微凹，偶具短尖頭，全緣，葉面光滑或疏披柔毛，青色或淡青色，葉背有白色長柔毛。總狀花序，頂生或腋生，與葉近等長，花疏生，10～20朵。總花梗長５～13cm，至果期明顯伸長，苞片線狀披針形，長２～５mm，背面被白色柔毛。小花梗長３～４mm，連同花軸密被棕色或黑色柔毛，小苞片２枚。花萼鐘狀，外面被白色或黑色柔毛，萼筒近無毛，萼齒短，三角形～鑽形，長爲萼筒1/4～1/5，有毛。蝶形花冠，黃色或淡黃色，旗瓣倒卵形，長12～20mm，基部具短瓣柄，先端微凹，翼瓣較旗瓣略短，瓣片長圓形，基部具短耳，瓣柄較瓣片長1.5倍，龍骨瓣與翼瓣約等長，瓣片半卵形，瓣柄略比瓣片長。子房被疏柔毛，子房柄長，柱頭無毛。莢果膜質膨脹，半橢圓形，長２～３cm，寬８～12mm，先端尖刺狀，兩面被黑色細短硬毛（圖４），１室，果頸露出宿萼外，微具網紋，種子３～８粒，腎形，長約３mm，寬１～２mm，平滑，黑褐色。「membranaceus」是「屬於膜的、似膜的（指莢果）」之意[38]。

蒙古黃耆（*A. membranaceus* var. *mongholicus*）亦是黃耆亞屬〔Subgen. *Phaca*（Linn.）Bunge〕膜莢組（Sect. *Cenantrum* Koch）之多年生草本植物[2]。如圖２所示，株高40～150cm。主根深長，長可達100～200cm，棒狀，極少有側根，稍帶木質。莖直立或斜生，單莖或２～５莖叢生，上部多分枝，光滑或疏披長柔毛。奇數羽狀複葉，互生，長５～10cm，葉柄長0.5～1cm；托葉離生，卵形、披針形或線狀披針形，長４～10cm，無毛或疏被白柔毛；小葉對生，25～37片，橢圓形或類圓形，長５～10mm，寬３～5mm，基部圓形，先端鈍圓或微凹，偶具短尖頭，有時不明顯，全緣，葉面光滑或疏披柔毛，綠色或青綠色，葉背有白色長柔毛。總狀花序，頂生或腋生，與葉近等長，花軸密被棕色或黑色柔毛，花疏生，５～22朵。總花梗長５～13cm，至果期明顯伸長，苞片線狀披針形，長２～５mm，背面被白色柔毛。小花梗長３～４mm，密被棕色或黑色柔毛，小苞片２枚。花萼鐘狀，外面被白色或黑色柔毛，萼筒近無毛，萼齒短，三角形～鑽形，長爲萼筒1/4～1/5

，有毛。蝶形花冠，黃色或淡黃色，旗瓣倒卵形，長12～20mm，基部具短瓣柄，先端微凹，翼瓣較旗瓣略短，瓣片長圓形，基部具短耳，瓣柄較瓣片長1.5倍，龍骨瓣與翼瓣約等長，瓣片半卵形，瓣柄略比瓣片長。子房無毛，子房柄長，柱頭無毛。莢果膜質膨脹，半橢圓形，長２～３cm，寬８～12mm，先端尖刺狀，光滑無毛，１室，果頸露出宿萼外，具網紋，種子８～10粒，腎形，長約３mm，寬１～２mm，平滑，黑褐色。「mengholicus」爲「蒙古的」之意[38]。

如圖３所示，多序岩黃耆（*H. polybotrys*）植物高50～80cm。莖直立狀，上部多分枝，光滑無毛。奇數羽狀複葉，互生，托葉長披針形，基部連合，小葉７～25片，卵狀矩圓形或矩圓狀披針形，長５～23mm，寬３～10mm，先端圓或微缺，有小尖頭，基部鈍圓，全緣，葉面光滑或疏披毛，葉面無毛或疏被毛，葉背主脈處有柔毛。總狀花序腋生，長達15cm，具花20～25朶。花梗絲狀，長２～３mm；花萼斜鐘狀，最下部一枚萼齒較其餘４枚萼齒長一倍。花冠淡黃色，長約10mm，旗瓣長圓狀倒卵形，翼瓣較旗瓣等長，但均較龍骨瓣短，龍骨瓣長13～16mm。莢果有３～５個莢節，呈連珠狀，莢節橢圓形，寬約６mm，有明顯網紋，邊緣有狹翅，扁平，表面伏貼短柔毛，成熟後不開裂（圖５），種子１粒[3]。

四、根外部與橫斷面之形態與質地

如圖６－A所示，*A. membranaceus* 之根呈圓柱形或向下漸細，少分歧，長40～90cm，粗端直徑1.2～3.5cm，表面黃白色，縱皺紋不明顯，皮孔橫長且有支根痕（表１）。質堅硬而韌，不易折斷。如圖７－A所示，斷面纖維性強，富粉質，平整橫切面之栓皮層淺褐色，略彎屈。皮部黃白色，窄，僅佔半徑2/5～3/5，具不規則彎屈的徑向放射裂隙，木質部黃色至淺棕黃色，有規則放射紋理與裂隙。自中心向外常有放射狀裂隙，老根之中心部多呈枯朽狀，爲褐色或空洞狀。氣微，味甜，嚼之有豆腥味。以條粗長，皺紋少，粉性足，味甜者爲良。

如圖６－B所示，*A. mongholicus* 之根呈圓柱形或向下漸細，少分歧，長40～90cm，粗端直徑1.2～3.5cm，表面淡黃色至棕褐色，有明顯縱皺紋，多且深，且有少數支根痕，皮孔橫長。質堅硬而韌，不易折斷，但較膜莢黃耆根稍柔軟；如圖７－B所示，斷面纖維性強，富粉質，平整橫切面之栓皮層淺褐色，略彎屈。皮部黃白色，寬廣，約占半徑2/5～3/5，具不規則彎屈的徑向放射裂隙，木質部黃色至淺棕黃色，有規則放射紋理與裂隙。自中心向外常有放射狀裂隙，老根之中心部多呈枯朽狀，爲褐色，或呈空洞狀。氣微，味甜，嚼之有豆腥味。以條粗長，皺紋少，粉性足，味甜者爲良。

如圖６－C所示，*H. polybotrys* 之根圓柱形，少有分歧，上端略粗，長20～120cm，粗端直徑１～２cm，表面灰紅棕色至紅褐色，有縱皺紋與少數支根痕，皮孔橫長，色淺，略突出。外皮易呈片狀脫落，剝落處黃白色。質地堅韌，不易折斷。如圖７－C所示，折斷面纖維性，並顯粉性，平整橫切面之栓皮層紅棕色，皮部黃白色，約佔半徑1/3～1/2，形成層環狀，淡棕色，木質部淡黃棕色，中央顏色較淺，近黃白色，髓線放射狀。氣微，味甜。

五、根之內部組織

如圖９－A所示，以顯微鏡檢視 *A. membranaceus* 根（根中部直徑約0.8～1.2cm）之橫斷面，最外緣爲木栓層，由５～20層木栓細胞組成，細胞呈長方形，切線性延長，整齊排列，細胞壁木化且栓化，長20～60μm，寬８～20μm；栓內層由３～６層厚角細胞組成，細胞切線性延長，長30～120μm，寬10～30μm，內側細胞較大，切向壁與角隅處不均勻增厚，徑向壁較薄，有時可見單紋孔；石細胞存在篩部外側，稀少，單個或２～３個成群，層紋可見，孔溝少，裂隙長，偶見次生壁間分離，弱木化，長70～260μm。維管束與髓線相間，呈同心性放射狀排列。韌皮部約佔半徑1/3～1/2，由韌皮纖維束、韌皮薄壁細胞與篩管群組成；韌皮薄壁細胞呈類圓形、橢圓形、類長方形或不規則形，長40～80μm，寬15～40μm，外側薄壁細胞通常破裂呈裂隙狀；韌皮纖維多６個集結成束，偶見單個散生，同心性放射狀排列，斷續成環，細胞壁厚，約８～12μm，木化或不木化，有的可見裂

隙狀孔溝，靠近形成層處纖維壁較薄，約2～4 μm；篩管群與韌皮纖維束交互排列，外側篩管群破裂而成裂隙狀或壓扁成帶狀。形成層環狀，由3～7層薄壁細胞組成，呈長方形，切線性延長。木部約佔半徑1/3，由木部纖維束、木部薄壁細胞與導管群組成；導管單個散生，或2～4個連生，類圓形或橢圓形，同心性放射狀排列，強木化，直徑約25～160μm，導管間或其周圍有木部纖維束，偶見木部纖維散生，有厚壁與薄壁兩種木部纖維，薄壁木纖維存在靠近形成層處，壁厚2～3 μm，弱木化，厚壁纖維較多，壁厚4～6 μm，木化；木部柔細胞呈三角形、類圓形、長方形或不規則形，長15～40μm，寬10～30μm，壁略厚，不木化，但導管周圍之木部柔細胞弱木化，偶見壁孔；髓線由3～7列薄壁細胞組成，細胞類長圓形或長方形，近外側細胞較長，近木栓層處常彎曲，有裂隙，偶見有石細胞。澱粉粒類圓形、橢圓形或類腎形，直徑5～15μm。

如圖9－B所示，以顯微鏡檢視 *A. mongholicus* 根（根中部直徑約0.8～1.2cm）之橫斷面，最外緣爲木栓層，由6～12層木栓細胞組成，細胞長方形，切線性延長，整齊排列，細胞壁木化且栓化，長15～50μm，寬5～20μm；栓內層由3～5層厚角細胞組成，細胞切線性延長，長30～115μm，寬10～25μm，切向壁與角隅處不均勻增厚，徑向壁較薄，有時可見單紋孔；石細胞存在篩部外側，稀少，單個或2～3個成群，層紋約略可見，孔溝少，裂隙長，偶見次生壁間分離，弱木化，長60～170μm。維管束呈同心性放射狀排列。韌皮部，約佔半徑1/2，由韌皮纖維束、韌皮薄壁細胞與篩管群組成；韌皮柔細胞呈類圓形、橢圓形、類長方形或不規則形，長35～75μm，寬15～40μm，外側薄壁細胞通常破裂呈裂隙狀；韌皮纖維多20～40個集結成束，偶見單個散生，同心性放射狀排列，細胞壁厚，約8～12μm，木化或不木化，有的可見裂隙狀孔溝，靠近形成層處纖維壁較薄，約2～4 μm；篩管群與韌皮纖維束交互排列，外側篩管群破裂而成裂隙狀或壓扁成帶狀。形成層環狀，由3～7層薄壁細胞組成，呈長方形，切線性延長；導管單個散生，或2～5個連生，類圓形或橢圓形，排列不規則，強木化，直徑25～160μm，導管間或其周圍有木部纖維群，偶見木部纖維散生，有厚壁與薄壁兩種木部纖維，薄壁纖維存在靠近形成層處，壁厚2～3 μm，弱木化，厚壁4～6 μm，木化；木部柔細胞呈類圓形、長方形或不規則形，長15～40μm，寬10～25μm，壁厚，不木化，但導管周圍之木部柔細胞弱木化，偶見壁孔；髓線不明顯，由1～2列薄壁細胞組成，細胞類長圓形或長方形，近外側細胞較長，近木栓層處常彎曲，有裂隙；中央爲初生木部，由導管、柔細胞與木部纖維組成。澱粉粒多單粒，類圓形、橢圓形或類腎形，直徑2～20μm。複粒由2～4分粒組成。

如圖9－C所示，以顯微鏡檢視 *H. polybotrys* 根（根中部直徑約0.6～1.2cm）之橫斷面，最外緣爲栓皮層，淡黃色，10～15層，細胞壁薄，細胞呈長方形、扁長方形，已有部分脫落。栓內層，狹窄，由厚角細胞2～4層，細胞呈長方形，類長方形，偶有細胞間隙，與韌皮部相接處，散見有篩部纖維束。維管束與髓線相間，呈同心性放射狀排列。韌皮部，約佔半徑1/3～1/2，由韌皮薄壁細胞、韌皮纖維束、篩管群等組成；韌皮柔細胞呈類圓形、橢圓形或不規則形，內含豐富的澱粉粒；韌皮纖維束，微木化，壁厚，細胞呈類方形、類多邊形、類圓形、不規則形，四周常有草酸鈣方晶而形成結晶纖維，細胞呈長方形、類圓形、類方形、類多邊形，具有略明顯的細胞間隙，內含豐富的澱粉粒；篩管群多位於形成層外側，而初生篩部的篩管呈頹廢狀。形成層斷續呈環，由6～11層薄壁細胞組成，呈長方形，切線性延長。木質部，約佔半徑1/3～1/2，由導管、木部纖維束、木部薄壁細胞與髓線細胞所組成；導管巨大，單個散生或2個連生，徑95～150μm，或更大，細胞呈類圓形、類橢圓形、類卵圓形；木部薄壁細胞，細胞呈類長方形、類方形、類多邊形、類圓形，內含豐富的澱粉粒；木部纖維束，微木化，壁厚，細胞呈類方形、類多邊形、類圓形、不規則形，四周常有草酸鈣方晶而形結晶纖維（圖12），結晶細胞壁不均勻增厚，草酸鈣方晶直徑7～15μm，長約至20μm，髓線明顯，由2～8列薄壁細胞組成，細胞小呈扁平狀。中央爲初生木部，由導管、柔細胞與木部纖維組成。

四、根之粉末特徵

如表 3 所示，*A. membranaceus* 根粉末爲黃白色，木栓細胞微黃綠色，表面觀呈類方形或類多角形，細胞壁微波狀彎曲；纖維成束或散離，直徑10～30μm，壁厚，表面有縱裂紋，初生壁常與次生壁分離，兩端常斷裂成帚狀或較平截，斷面呈三角形，卵圓形或類圓形，導管主爲緣紋孔導管，直徑25～160μm，具緣紋孔排列緊密，另有網紋導管，網紋一有緣紋導管；澱粉粒較多，單粒，類圓形、橢圓形或類腎形，直徑 5 ～15μm，複粒由 2 ～ 4 分粒組成，石細胞稀少，類三角形或類方形，長徑約70～260μm，短徑15～60μm，層紋可見，孔溝少。

如表 3 所示，*A. mongholicus* 根粉末爲黃褐色，木栓細胞微黃綠色，表面觀呈類方形或類多角形，細胞壁微波狀彎曲；纖維成束或散離，直徑10～30μm，壁厚，表面有縱裂紋，初生壁常與次生壁分離，兩端常斷裂成帚狀或較平截，斷面呈三角形，卵圓形或類圓形；導管主爲緣紋孔導管，直徑25～160μm，具緣紋孔排列緊密，另有網紋導管，網紋一緣紋孔導管；澱粉粒較多，單粒，類圓形、橢圓形或類腎形，直徑 2 ～20μm，複粒由 2 ～ 4 分粒組成，石細胞稀少，類三角形或類方形，長徑約60～1700μm，短徑15～55μm，層紋約略可見，孔溝少。

如 3 所示，*H. polybotrys* 根粉末淡黃褐色。以顯微鏡檢視其粉末，表面觀之木栓細胞，呈淡黃色，壁薄，微木化，細胞呈多角形，大小均勻，排列整齊。韌皮薄壁細胞，有呈略扁的類雙錐形、長方形、類方形、類多邊形，不規則形之草酸鈣方晶，內含豐富的澱粉粒。纖維一般成束，偶見散離，細長，微彎曲，末端漸尖，斷端平截，微木化或非木化，四周常有草酸鈣方晶橫長排列而形成結晶纖維（圖 8 ）。導管，徑95～150μm，或更大，主爲有緣孔紋導管，偶見有網紋導管。澱粉粒，極多，單粒呈類圓形、橢圓形、類卵圓形，徑 5 ～20μm，臍點爲點狀、裂縫狀、三叉狀、人字狀、層紋不明顯；複粒，稀少，由 2 ～ 6 分粒組成。

討　　論

一、黃耆之藥名、產地與來源植物之探討

歷代正統本草皆以黃耆爲主要名稱。明・本草綱目・時珍曰：「黃耆，長也。黃耆色黃，爲補藥之長，故名」[11]。說文曰：「耆，老也，爲會意、形聲字」，「耆乃老旨之合字，日乃旨字之略，旨爲甘美之法，蓋以年老則無外欲，僅好甘美之食，因此以老旨構成耆字，用以意味年老」[18]。而黃芪，或作黃蓍者，其語音及字意皆與耆殊異，蓍乃蓍龜之蓍，音尸[11]，大陸地區習用黃芪爲名，乃以芪爲耆之簡體字[6]，非正名也；其他別名如載糝[17]，或載椹、獨椹、蜀脂、百本、芰草[10]等，糝爲飯粒之意，椹爲桑果，脂是脂肪，芰乃植物名，爲四角之菱[23]，此多爲營養之物，尤其名醫別錄稱：「黃耆生蜀郡山谷」，蜀脂之意是否由此引申爲川產富營養之物，已不得知，或另有他義，更不復可考；另有王孫之名，而王孫與牡蒙係同名異物[11]，不應與黃耆混爲一談。故考證歷代本草，仍以「黃耆」爲正名。

如本草之記載，黃耆之主產地，自唐朝起，已由我國中西部之四川開始，迄今逐漸移往東北之大興安嶺與黑龍江一帶，顯然所謂黃耆因使用野生品，而將某產地之黃耆採摘殆盡，以致主產地逐漸北移之說，或有可能[15]，且黃耆屬植物曾供藥用不下25種，產地之遷移，其品種必有替代或混雜，道地藥材已不易查考，僅能約略鑑別，如「色黃白」，甜美[17]；根至柔韌，皮微黃褐色，肉中白色[19]」，頗類似黃耆屬植物之乾燥根與其橫斷面（圖 6 －A，圖 7 －A），「根長二三尺，獨莖或叢生枝幹，去地二三寸[19]，其葉扶疏，作羊齒狀，似槐葉微尖小，又似蒺藜葉，闊大而青白色[20]；七月開黃紫花，其實作莢，子長寸許。八月中採根[19]」等敍述，皆類似黃耆屬植物之形態特徵，如膜莢黃耆（*A. membranaceus*）之莖直立，單生或 2 ～ 3 莖叢生；奇數羽狀複葉，互生；小葉片橢圓形，長橢圓形或長卵圓形，先端鈍尖、截形或微具短尖頭，全緣，青色或淡青色；花期 6 ～ 8 月，花冠淡黃色或淡紫色，莢果，長 2 ～2.5cm； 8 ～10月採根」（圖 1 ～ 2 ），東丈夫博士曾以秦嶺黃耆（又

稱烏拉持黃耆、賀蘭山黃耆、川綿耆、白綿耆）（*A. hoantchy Franchet*）爲正品[28]，亦有其可能性，而蕭培根博士認爲 *A. membranaceus* 或 *A. mongholicus*之形態特徵約略符合本草記載[12]，又爲藥典與中藥規範所收載，明定爲主要來源植物，則黃耆之正品應以此二者無疑。

一般將蒙古黃耆視爲膜莢黃耆之變種[15]，但依其植物學特性，則二者有顯著之不同，與膜莢黃耆比較時，蒙古黃耆植株較矮小，小葉數偏多（表1），葉面積小且形狀較鈍圓，莢果上光滑無毛，主根較長，棒狀，無側根但較細，根之縱皺紋十分明顯（表1，圖6－B），且原生木部不呈角星形（表2，圖9－B）。膜莢黃耆之染色體核型爲K(2n)＝16＝6m＋6sm＋2st＋2m（SAT），蒙古黃耆爲K(2n)＝16＝10m＋2sm＋4m（SAT）[4]，二者應是兩種不同植物，或如中國植物誌將二者同列變種，並不區分其演化先後，故學名分別記爲 *A. membranaceus* var. *membranaceus* 及 *A. membranaceus* var. *mongholicus*[2]，而王等（1992）更報導膜莢黃耆學名應記爲 *A. membranaceus*，蒙古黃耆則可記爲*A. mongholicus*[4]。

表 1. 膜莢黃耆、蒙古黃耆、多序岩黃耆原植物特徵之比較

Table 1. Phonotypical appearance of *Astragalus membranaceus, A. mongholicus* and *H. polybotrys*

Original Plant	Root		Stem	Leaflets	Capsule				
	Color	Wrinkles	Hair	Unit	Shape	Node	Veins	Hair	Mature
A. membranaceus	Yellow white	Few	Rich	11～27	Single	No	No	Rich	Open
A. mongholicus	Yellow	Obvious	Rich	25～37	Single	No	No	Smooth	Open
H. Polybotrys	Reddish brown	Few	No	7～25	Continuous	Yes	Yes	Few	Close

二、黃耆與紅耆之辨僞

黃耆類藥材主要來源植物爲 *A. membranaceus* 或 *A. mongholicus*，以其商品之根皮呈淡黃白色，又稱白皮耆或北耆；紅耆主要來源植物爲 *H. polybotrys*，商品名爲晉耆，或紅皮耆，以其根皮紅棕色或紅褐色與甜度極大而著名（圖3～4，表2），主產區甘肅省南部武都、宕昌一帶，以其根條粗長，稱之獨根，且因十分硬韌可製成馬鞭用，又稱馬鞭根。

表 2. 膜莢黃耆、蒙古黃耆、多序岩黃耆根橫切面組織特徵之比較

Table 2. Anatomical characteristics of cross section of root of *A. membranaceus, A. mongholicus* and *H. polybotrys*

Original plant	Cortex	Vascular boundle		Primary xylem
	Stone cell	Phloem : Xylem	Crys. fiber	Shape
A. membranaceus	Yes	1 : 1[z]	No	Star-like
A. mongholicus	Yes	1 : 1	No	No
H. polybotrys	No	2 : 1	Yes	No

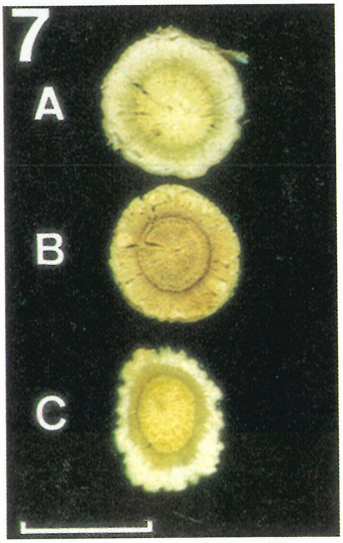
[z].Ratio of diameter of Phloem over Xylem.

歷代本草中，有關紅耆之記載，最早且唯一出現於漢・陶弘景・集注神農本草經 7 卷本：「黃耆，有赤色者，可作膏貼用，消癰腫，俗方多用，道家不須。」(10)，顯見漢朝時，紅耆已與黃耆之名稱混用，惟黃耆與紅耆外觀差距極大（圖 6），當時已能區別，且醫藥專家並未使用紅耆，而是民間或地區性用藥，製成膏貼後，用於消癰腫，故為外用製劑，雖現代藥理學實驗亦證實紅耆具有抗菌、鎮痛、抗炎與抗腫瘤等作用(1,33,34)，但黃耆主要用於補氣固表，現代臨床又用於抗衰老與增強免疫功能等疾病(5,7,8,9,25,32,40)，故抗菌、抗炎與鎮痛並非黃耆之療效重點；雖然紅耆多糖與黃耆多糖均具有增強免疫功能之作用(32,34)，但黃耆主要藥理活性成分 astragaloside Ⅳ(31,40)，並未在紅耆中發現，且紅耆含有大量草酸鈣結晶(36)（表 3，圖 8），對結石患者宜斟酌使用，然黃耆並無此困擾(28)，故使用黃耆類藥材時，應將黃耆與紅耆區分使用。尤其*H. polybotrys* 之小葉數僅 7～25片（圖 3），莢果有莢節呈連珠狀、成熟不開裂（圖 5），種子僅 1 枚；根紅棕色或紅褐色；原生木部不呈角星形，具有結晶纖維及大量草酸鈣結晶等特徵，極易與黃耆區分。

表 3. 膜莢黃耆、蒙古黃耆與多序岩黃耆根粉末特徵之比較表

Table 3. Root powder quality of *A. membranaceus*, *A. mongholicus* and *H. polybotrys*

Original plants	Color	Stone cell	Crys. fiber	Cal. oxalate
		Diameter (μm)		
A. membranaceus	Yellow white	70～260	No	No
A. mongholicus	Yellow white	60～170	No	No
H. polybotrys	Yellowish brown	No	Rich	Yes



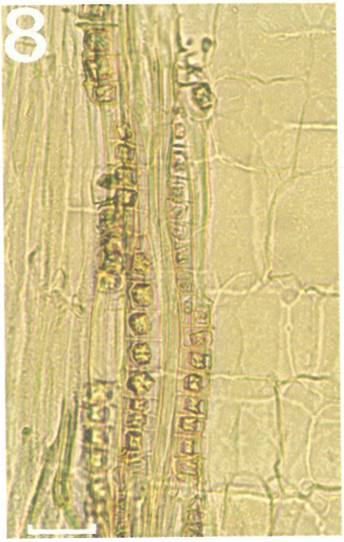


圖　1. 膜莢黃耆植物
Fig 1. Plant of *A. membranaceus*
圖　2. 蒙古黃耆植物
Fig 2. Plant of *A. mongholicus*
圖　3. 多序岩黃耆植物
Fig 3. Plant of *H. polybotrys*
圖　4. 膜莢黃耆之果莢
Fig 4. Capsule of *A. membranaceus*
圖　5. 多序岩黃耆之果莢
Fig 5. Capsule of *H. polybotrys*
圖　6. 膜莢黃耆(A)、蒙古黃耆(B)與多序岩黃耆(C)之乾燥根
Fig 6. Phontypical appearance of root of *A. membranaceus* (A), *A. mongholicus* (B) and *H. polybotrys* (C)
圖　7. 膜莢黃耆(A)、蒙古黃耆(B)與多序岩黃耆(C)根之横斷面
Fig 7. Root sections of *A. membranaceus* (A), *A. mongholicus* (B) and *H. polybotrys* (C). (Bar=1cm)
圖　8. 多序岩黃耆根之結晶纖維
Fig 8. Crystal fibers of *H. polybotrys* (Bar=100 μm)

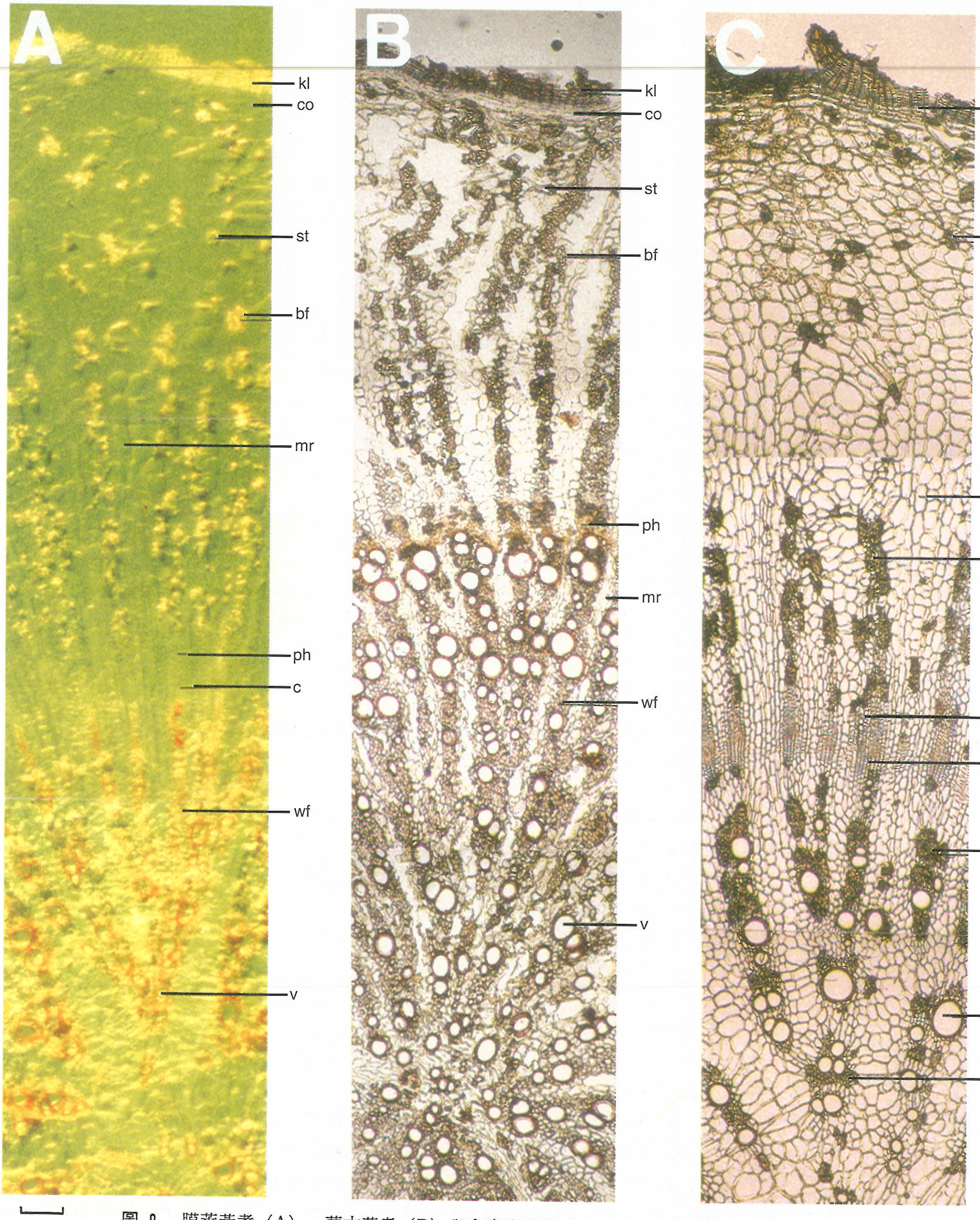


圖 9. 膜莢黃耆（A）、蒙古黃耆（B）與多序岩黃耆（C）根橫切面組織特徵之比較

Fig 9. Anatomical characteristics of cross section of root of *A. membranaceus* (A), *A. mongholicus* (B) and *H. polybotrys* (C). (Bar=100μm)

誌　謝

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Pharmacognostical Studies on Astragali Radix (I) Identification of *Astragalus membranaceus*, *A. Mongbolicus* and *Hedysarum polybotrys*[1]

Yu-Chin Lin[2], Yuan-Shiun Chang[2] and Hsin-Sheng Tsay[3]

Summary

Huangqi (Astragali Radix) was first recorded in Shen-Nung-Ben-Cao-Jing under Inferior Category and was also recorded in the successive Ben-Cao of subsequent dynasties. The plethora of synonyms and complexity of the original plants of this drug have affected its quality specification and clinical efficacy. After investigation, we discovered that the standard name should be Huangqi (黃耆) , and *Astragalus membranaceus* (Fisch.) Bunge var. *membranaceus* and *A. membranaceus* (Fisch.) Bunge var. *mongholicus* (Bunge) P. K. Hsiao were the plant origin. Of the two plants, *A. mongbolicus* is much smaller with many leaflets, which are smaller and more obovate. Its capsule is smooth, and the main root is longer, but thinner. Longitudinal wrinkles are evident on the surface. The size of the stone cell is smaller. Furthermore, the primary xylem of root cross section is not star-like. In Taiwan, Hongqi (紅耆) is used as a substitute for Huangqi. This substitute comes from *Hedysarum polybotrys* Hand.-Mazz., which is larger than *A. membranaceus,* with leaflets that are larger, more oblong, but fewer in number. The mature capsule does not open. The main root surface is reddish brown in color, and tastes sweet. It has no stone cell in the root, and the primary xylem of root cross section is not star-like, but has more crystal fibers and calcium oxalate crystals. According to this study, we conclude that hongqi differs from hungqi in many respects, and there should not be used as a substitute. The two should be carefully distinguished in clinical use.

Key words: *Astragalus membranaceus, Astagalus mongbolicus, Hedysarum bolybotrys,* Anatomy.

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不同輪作制度田微生物相之調查研究[1]

I. 囊叢枝內生菌根菌與溶磷菌之變動

吳繼光　劉燕雪　簡宣裕　譚增偉[2]

摘要：本微生物相調查研究係在農業試驗所內的六十八號試驗田進行。在1993年一月至1994年十二月的調查期間，每年各有兩個休耕期，一在七月至八月間，另一在一月至四月間。在這兩個休耕期中，全年的內生菌根菌產孢量，以一月至四月間的休耕期最高，顯示休耕期的田間雜草可能扮演著重要角色。有關內生菌根菌的產孢量比較，以玉米連作田的每百克土含孢量最低（4—8孢子／100克土），其可能原因與土壤中有效磷含量有關。1994年的產孢量較1993年同期的產量爲少。整理1993年資料發現內生菌根菌孢子產量與溶磷菌族群數有互爲消長的現象。這種現象，在三月至七月的第一期作生長期間最明顯。在三月初期，內生菌根菌孢子數最多而溶磷菌數相對減少。反之，在七月時溶磷菌逐漸增多而內生菌根菌孢子減少。在九月至十一月期間種植二期作時，在水稻連作區與玉米連作區，卻發現溶磷菌數與內生菌根菌，亦有類似消長的現象。但在一期水稻二期玉米的輪作區，與一期玉米二期水稻的輪作區，則有不同的族群變化。在一期水稻二期玉米的輪作區內，二期作的溶磷菌數與內生菌根菌數皆有增加的趨勢。而在一期玉米二期水稻的輪作區內，溶磷菌數與內生菌根菌則有相對減少的現象。整理1994年的資料顯示內生菌根菌孢子產量與溶磷菌族群數雖有互爲消長的現象，但卻有不同的變化。此外內生菌根菌的種類與前一年的結果相較，並沒有明顯的差異，可見*Glomus mosseae* 與水稻有密切相關的依存度；而在輪作區與玉米連作區內則 *Glomus geosporum, Glomus manihotis, Acaulopora elegans* 有明顯的相關性。

關鍵詞：微生物相、叢枝菌根菌、溶磷菌、消長。

土壤微生物在生態平衡上是一群重要的分解者，對於土壤有機質的分解及肥力之維持均功不可沒[3]。但也有許多土生病原菌會寄生在作物根部而造成嚴重病害，甚至危害人類的生存。在歷史上，*Phytophthora infestans*（Mont.）de Bary 就曾造成嚴重的馬鈴薯腐疫病（Potato late blight），使得約二十五萬愛爾蘭人民因飢餓而死亡[1]。無論是有益或有害於作物生長的微生物均同時存在於土壤中，且會因土壤環境因子（氣候，作物，土壤肥力，農業藥物…等）的改變而互爲消長[9,18]。研究如何提升有益土壤微生物的活動力（activity）來改善土壤肥力及抑制有害土生病原菌的數量，一直是土壤微生物界努力的方向之一。作物的輪作及水田和旱田的輪換制度，便是改善土壤微生物生態的一種手段[1,8,13,14]。本研究的目的是擬觀察不同輪作制度田有益微生物，如溶磷菌，菌根菌等微生物相在根圈土壤中互動消長的變化情形，以提供研究不同輪作田之土壤微生物生態，肥培管理，及作物土生病害防治參考用。

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材料與方法

本研究係利用位於霧峰本所農場的68號實驗田進行。該實驗田使用於輪作試驗已有8年，有關各項土壤肥力變化等背景資料均已搜集完備。此次調查的輪作制度計有：（1）水稻連作（2）玉米連作（3）一期水稻，二期玉米（4）一期玉米，二期水稻。在每一輪作制度中，均有一雜草分隔帶，將其區分爲兩個小區。每月採樣時，在每個輪作田區內設六個區集。每一區集以4公尺平方爲限並該區內隨機取樣8個樣品。每一樣品係以直徑5cm的採樣器所採得。採土深度自表土以下15cm採樣後，8個樣品將予以合併成一混合樣品。採樣的時間將自1993年1月份起至1994年12月底止。

一、囊叢枝內生菌根菌的分離與數量估算

在每一混合樣品中，稱取100克土後，以濕篩法和糖液離心法[5]分離孢子後，在立體顯微鏡下計算孢子數量並挑取孢子，以 Polyvinyl alcohol lactophenol glycerol（PVLG）[10]或 Hoyer's 包埋劑製成半永久片，以利於孢子的鑑定與標本之保存。孢子的鑑定與資料之紀錄將採 Schenck and Perez[16]所建議的步驟進行。經鑑定後，屬於臺灣新記錄或世界新種的孢子，將以百喜草或其他適當的宿主，在溫室中培養繁殖以供進一部研究其對作物的生產效益。

二、溶磷菌的分離與數量估算

在每一混合樣品中，稱取適量的土經過適當的稀釋後，以三角玻棒均勻塗抹於 Young[20]平板培養基上，並置於攝氏25度的培養箱中培養。經過數天後，觀察菌落溶磷現象並計算菌落數。

結果與討論

一、叢枝內生菌根菌

在臺灣省農業試驗所的68號田區，其水稻連作的土壤酸鹼值變化較穩定，在5.0到6.0之間。水稻根圈土壤中主要的內生菌根菌種以*Glomus mosseae* 爲主（表1）。在兩年的調查結果顯示，此一菌種與水稻的親合性十分穩定，且產孢高峰期在一月至四月間。（圖1）。這期間恰逢休耕且稻田內長滿雜草。田間雜草顯然與土壤中囊叢枝內生菌根菌族群的連繫有關。這點與Ilag 等人[7]的發現相似。水稻與玉米輪作的田區，在根圈土壤中可發現主要內生菌根菌種爲*Gl. mosseae*（Nicol. & Gerd.）Gerdemann & Trappe, *Gl. geosporum*（Nicol. & Gerd.）Walker 和 *Gl. manihotis* Howeler, Sieverding & Sckenck。其中 *Gl. geosporum* 和 *Gl. manihotis*，主要與玉米有關。這點從玉米連作田間的根圈土壤中也可找到這兩種優勢菌種而獲得證實。此外，*Acaulospora elegans* Trappe & Gerdemann 也是另一與旱作有關的重要菌種。除玉米外，這菌種也常常出現在酸性土壤的玫瑰，甘藷或甘蔗的根圈土壤中[19]。由於*Gl. geosporum, Gl. manihotis,* 和 *Acaulospora elegans* 在旱根圈內是優勢菌種。吾人似可進一步做接種試驗，以確知其促進作物生長的效果，進而開發成爲新的菌種供農民使用。

從試驗田區的分隔地帶的雜草根域土壤中（圖2），發現土壤的酸鹼值（6.20）較所有四種耕作制度田土的酸鹼值爲高，且在第三與第四耕作制度田區的分隔地帶的雜草根域中發現*Scutellispora gilmorei*（Trappe & Gerd.）Walker & Sanders 。由以上的調查結果顯示，農作物經長期種植後，會對該農作田內的菌根菌產生選擇性的篩選作用。這點與 Schenck and Kinloch[15]所做的結論相同。若比較不同輪作制度田中每一百克土壤每月的孢子平均含量（表2），其中以玉米連作田所含孢子數最少，水稻田所含孢子數量最多其次爲一期玉米、二期水稻的輪作田。推究其原因可能是由於玉

米田水中含有較多量的有效磷所致（表3）[6,11]。此外，1994年的產孢量也較1993年同期的產量爲少。原因並不明確，有待進一步觀察後確認。另經由本次調查可知本所輪作田中每百克土壤所含孢子數(4—22孢子／100克土)，若與加拿大安大略省玉米田所含孢子數相較(4,000—7,000孢子／100克土)[17]，則明顯偏低，實有添加菌根菌種或延長休耕期以增加菌根菌數並減少化學肥料施用的必要。

表 1. 在四種不同耕作制度下內生菌根菌的種類
Table 1. Species found in different cropping systems

Cropping systems	pH	Species
I Rice-Rice continuous system	5.30～6.07(5.79*)[z] 5.50～6.04(5.67)[y] 5.60～6.29(6.00)[x]	*Glomus mosseae, Gl. geosporum*
grass zone	6.24～6.40(6.32)[w]	
II Rice-Corn corpping system	4.33～4.84(4.60) 4.24～4.89(4.50) 4.90～5.80(5.30)	*Glomus geosporum*
grass zone	5.91～6.72(6.32)	
IV Corn-Corn continuous system	3.95～4.40(4.13) 4.04～5.27(4.60) 5.10～5.64(5.30)	*Glomus geosporum, Gl. manihotis, Acaulospora elegans, A. laevis*
grass zone	5.93～6.38(6.16)	
III Corn-Rice cropping system	4.72～4.91(4.83) 5.03～5.38(5.19) 3.89～4.21(4.12)	*Glomus geosporum, Gl. manihotis, A. elegans, A. laevis*
grass zone	5.86～6.40(6.13)	

* average of pH
[z] Data of December, 1992
[y] Data of February, 1993
[x] Data of 1994
[w] Data of April, 1994

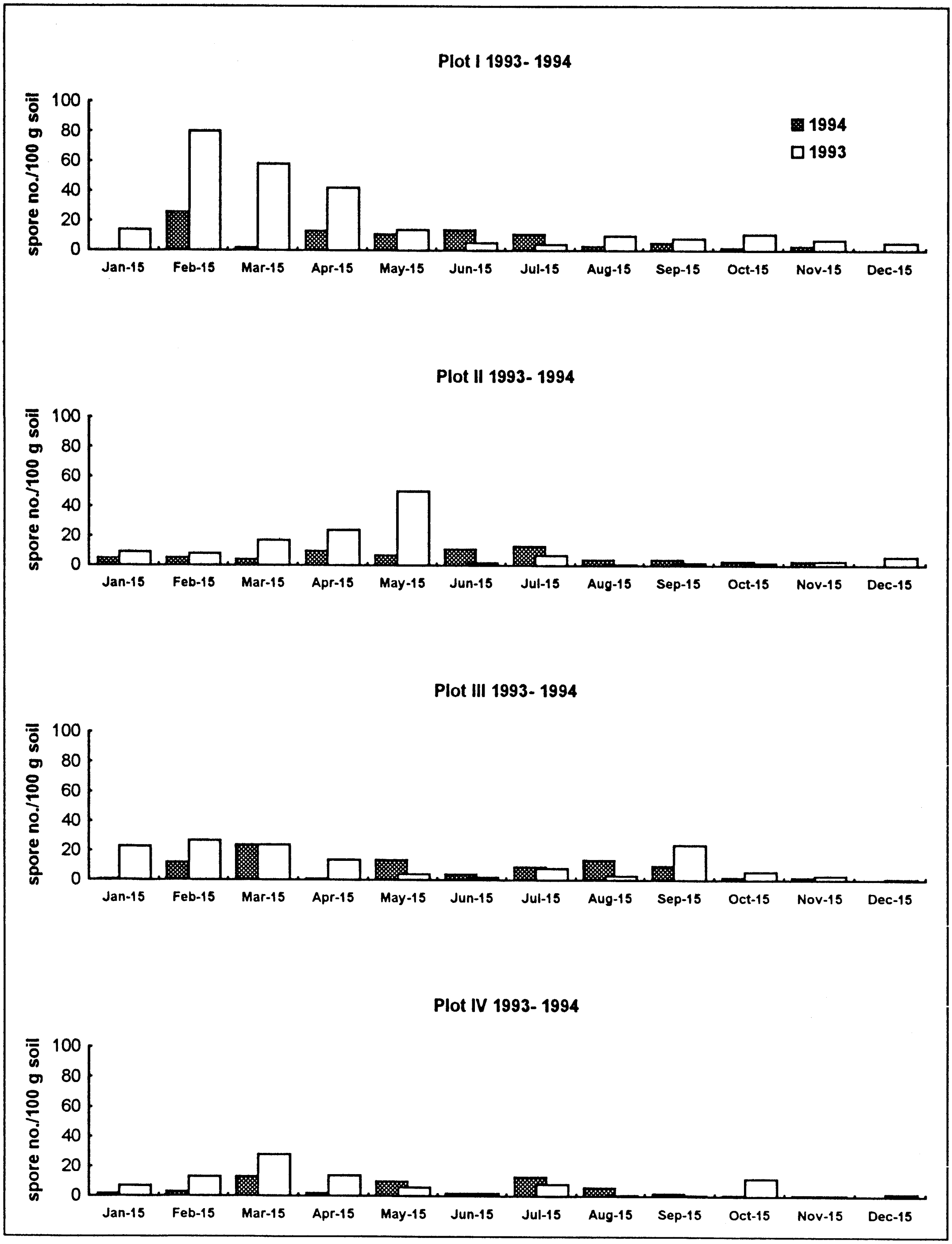

圖 1. 叢枝內生菌根菌在不同輪作制度田的變化情形。第一區：水稻連作區　第二區：一期水稻二期玉米輪作區　第三區：一期玉米二期水稻輪作區　第四區：玉米連作區

Fig. 1. Spore production of arbuscular mycorrhizal fungi in different cropping systems. Plot I-rice continuous cropping system, Plot II-1st rice-2nd corn rotation system, Plot III-1st corn-2nd rice rotation system, Plot IV-corn continuous system.

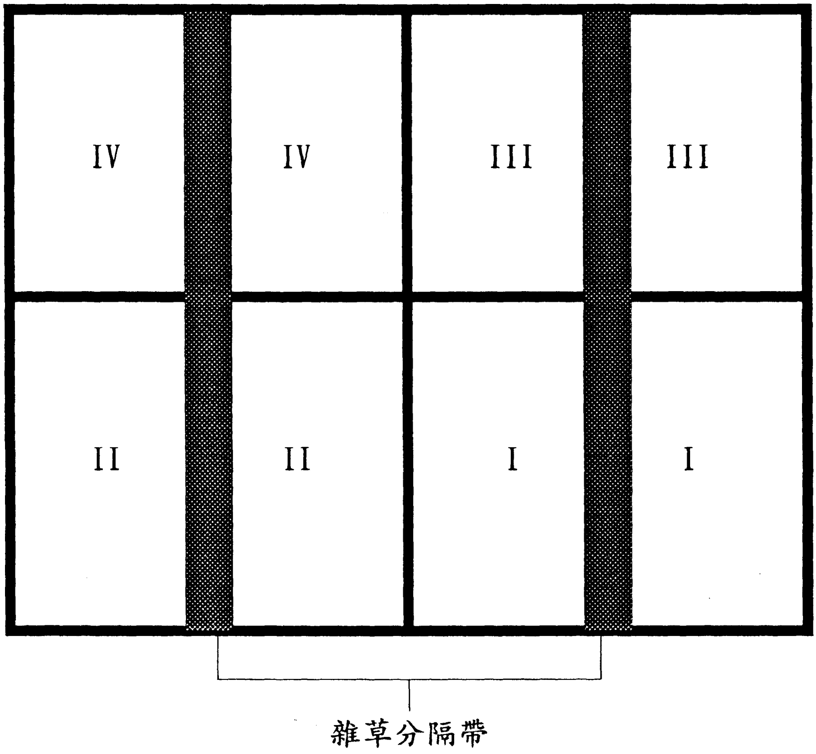

圖 2. 臺灣省農業試驗所六十八號田區試驗區域劃分概況

Fig. 2. Four cropping systems in #68 field, TARI. A grass zone segregates each plot into two parts.

表 2. 菌根菌孢子於四種輪作制度田中之月平均產量（每百克土）

Table 2. Arerage production of arbuscular mycorrhizal fungal spores in four cropping systems.

Year	Rotation Cropping Systems			
	I[y]	II	III	IV
1992[z]	6.80± 4.00	5.10± 5.20	10.00± 4.10	3.60±3.70
1993	21.50±29.80	10.92±15.15	11.61±10.84	7.86±9.21
1994	8.15±10.39	6.33± 4.75	8.54± 7.84	5.18±5.02

(spore no./100gm soil)

[z] data collected from July to December, 1992.

[y] I，II，III，IV same as in Table 1.

表 3. 四種輪作制度田中土壤有效磷含量之比較

Table 3. Quantitative comparison of available phosphate in four rotation cropping systems.

Bray-P (mg kg^{-1} soil)

Plots	1987(2nd)[z]	1988(2nd)	1989(2nd)	1990(2nd)	1991(2nd)	1992(1st)	1992(2nd)	1993(1st)
I[y]	11.3	13.2	35.5	18.3	22.5	28.0	23.2	26.5
II	12.7	3.7	35.7	33.8	26.8	24.0	42.3	27.2
III	9.7	11.3	33.2	20.0	24.7	29.0	26.7	46.0
IV	16.0	42.5	63.7	64.2	74.0	67.0	63.5	47.5

[z] sample collected after the crop harvested.
[y] I，II，III，IV same as in Table 1.

二、溶磷微生物

內生菌根菌的孢子產量與溶磷菌族群數有互為消長的現象。這種現象，在1993年三月至七月的第一期作生長期間最明顯（圖3）。在三月初期，內生菌根菌孢子數量最多而溶磷菌數相對減少。反之，在七月時溶磷菌逐漸增多。在九月至十一月期間種植第二期作時，在水稻連作區與玉米連作區，也發現溶磷菌數與內生菌根菌，有類似消長的現象（圖3，6）。但在一期水稻二期玉米的輪作區內，在九月至十一月期間，溶磷菌數與內生菌根菌數皆有增加的趨勢（圖4）。而在一期玉米二期水稻的輪作區內，溶磷菌數與內生菌根菌則有相對減少的現象（圖5）。在1994年的調查結果與1993年略有不同。在一期水稻田中菌根菌數量逐漸增加而溶磷菌卻在逐漸減少（圖7，8）。在一期的玉米田中菌根與溶磷菌皆隨著作物的成熟而逐漸減少（圖9，10）。在二期作中，無論是水稻或玉米，皆因不同輪作制度的變化而使得溶磷菌與菌根菌數量的消長有不同的差異。此種菌根菌與溶磷菌互為消長的現象，與過去所報導的菌根菌可促進或抑制根圈微生物的族群數顯然有所不同[2,4,12]。有關溶磷菌數與內生菌根菌族群互動的原因有待進一步的探討。

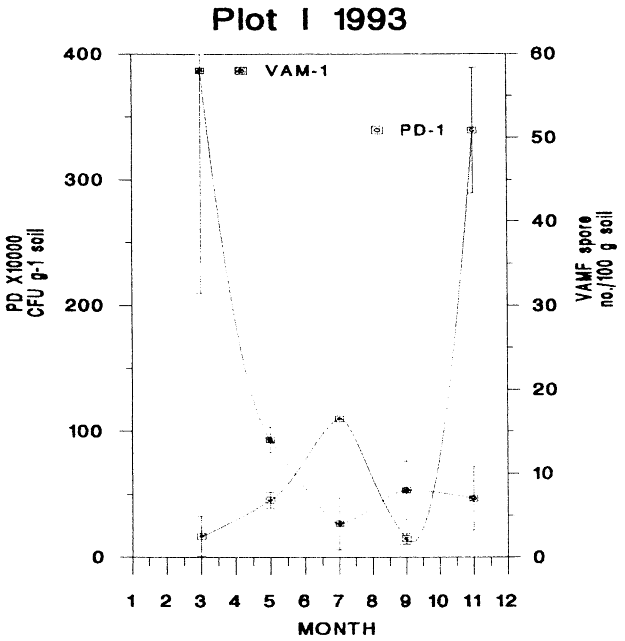

圖 3. 囊叢枝內生菌根菌與溶磷微生物在水稻連作制度下的消長情形

Fig. 3. Succession of arbuscular mycorrhizal fungi and phosphate-dissolving microbes (PD) in plot I-rice continuous cropping system.

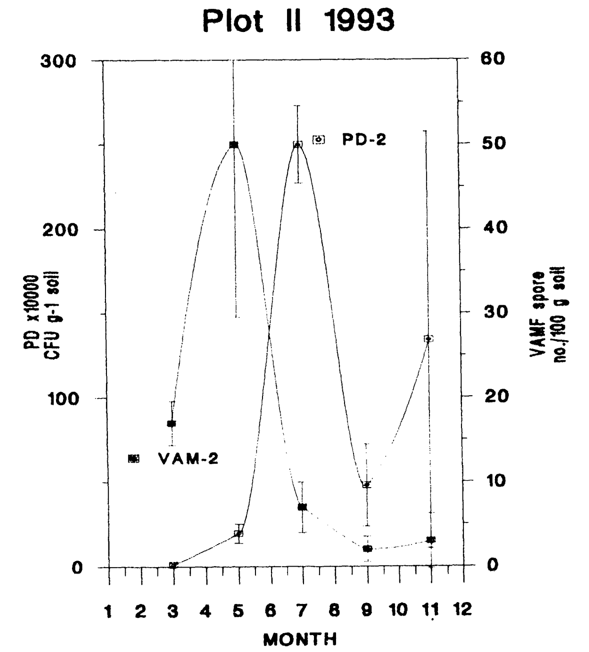

圖 4. 囊叢枝內生菌根菌與溶磷微生物在一期水稻、二期玉米輪作制度下的消長情形

Fig. 4. Succession of arbuscular mycorrhizal fungi and phosphate-dissolving microbes (PD) in plot II-1st rice-2nd corn rotation system.

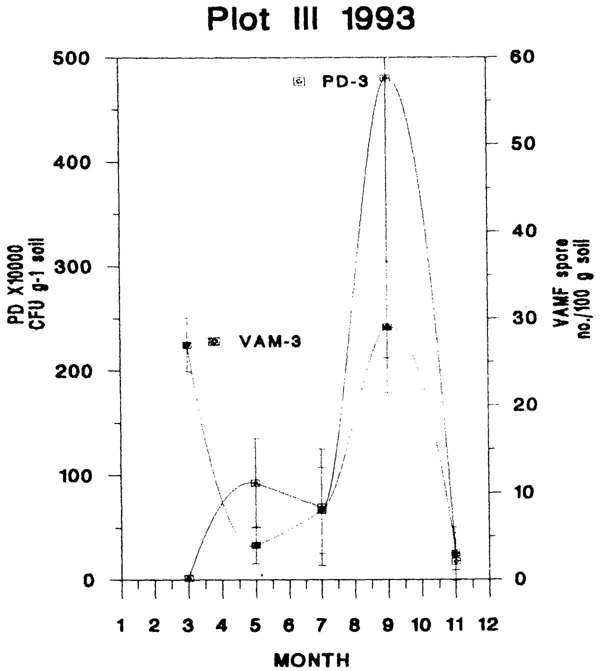

圖 5. 囊叢枝內生菌根菌與溶磷微生物在一期玉米、二期水稻輪作制度下的消長情形

Fig. 5. Succession of arbuscular mycorrhizal fungi and phosphate-dissolving microbes (PD) in plot III-1st corn-2nd rice rotation system.

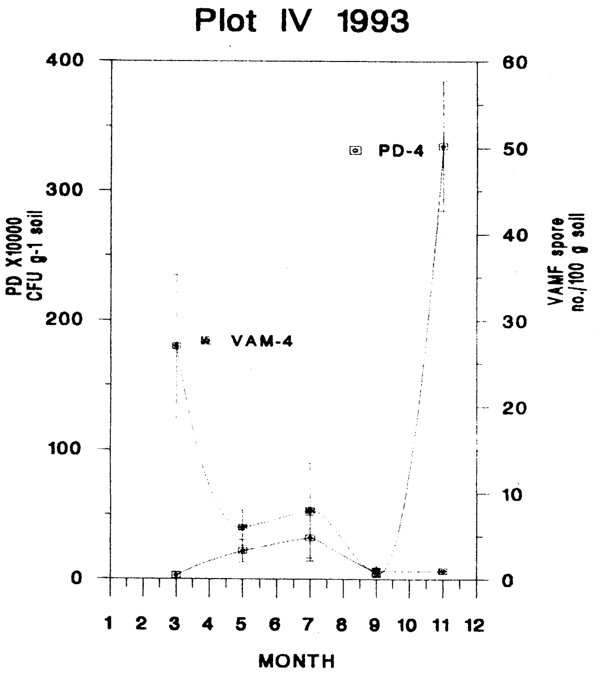

圖 6. 囊叢枝內生菌根菌與溶磷微生物在玉米連作制度下的消長情形

Fig. 6. Succession of arbuscular mycorrhizal fungi and phosphate-dissolving microbes (PD) in plot Ⅳ-corn continuous system.

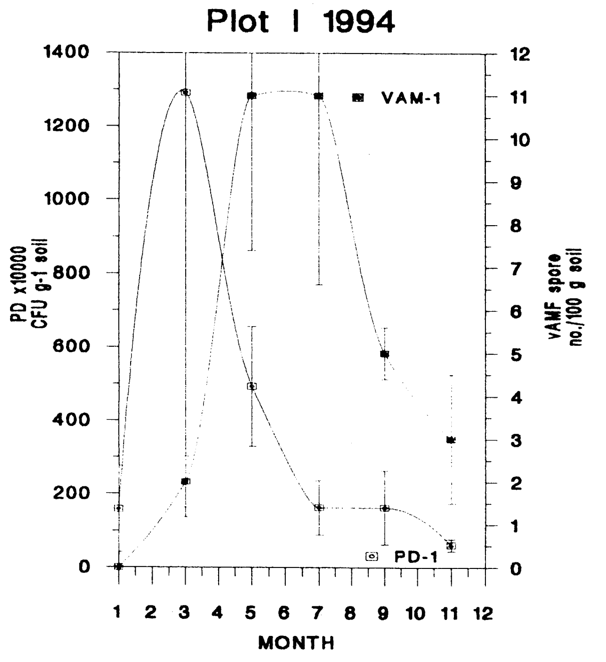

圖 7. 囊叢枝內生菌根菌與溶磷微生物在水稻連作制度下的消長情形

Fig. 7. Succession of arbuscular mycorrhizal fungi and phosphate-dissolving microbes (PD) in plot Ⅰ-rice continuous cropping system.

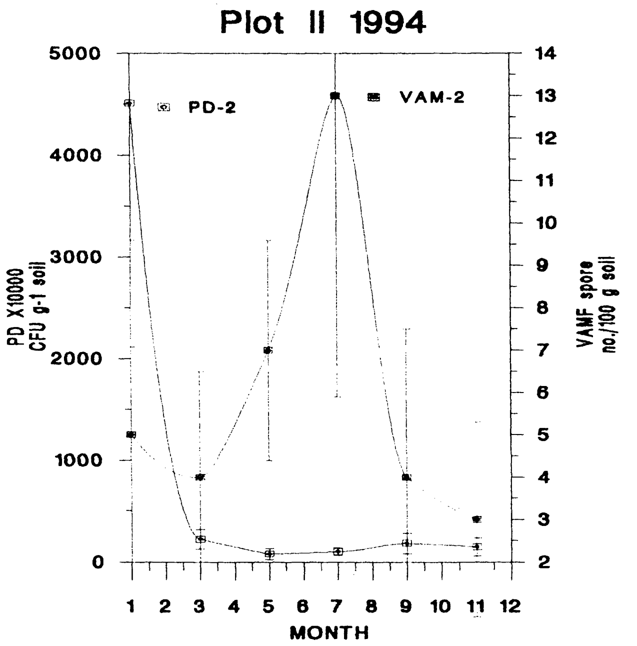

圖 8. 囊叢枝內生菌根菌與溶磷微生物在一期水稻、二期玉米輪作制度下的消長情形
Fig. 8. Succession of arbuscular mycorrhizal fungi and phosphate-dissolving microbes (PD) in plot II-1st rice-2nd corn rotation system.

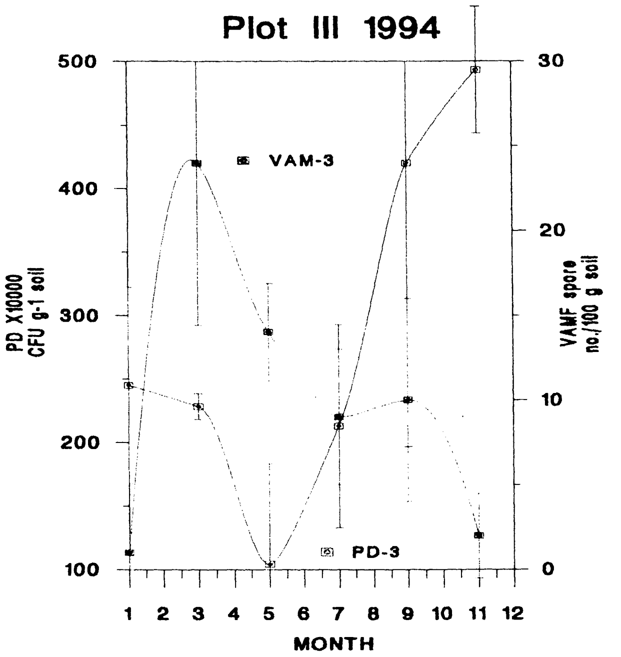

圖 9. 囊叢枝內生菌根菌與溶磷微生物在一期玉米、二期水稻輪作制度下的消長情形
Fig. 9. Succession of arbuscular mycorrhizal fungi and phosphate-dissolving microbes (PD) in plot III-1st corn-2nd rice rotation system.

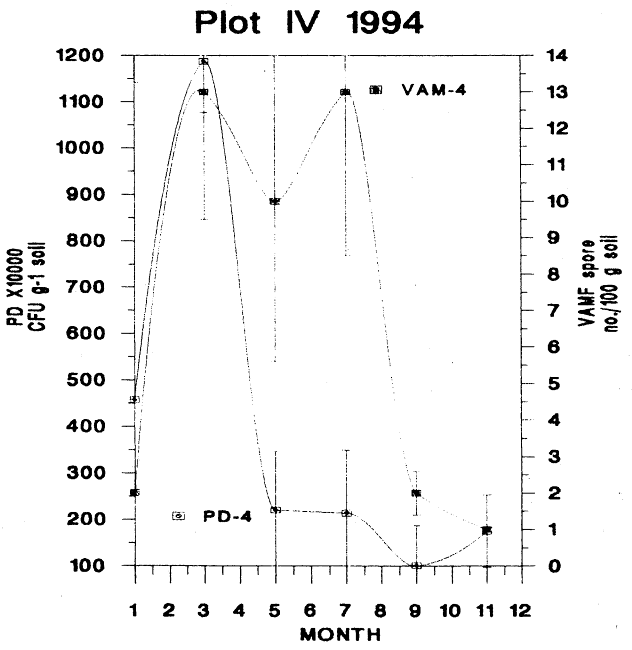

圖 10. 囊叢枝內生菌根菌與溶磷微生物在玉米連作制度下的消長情形

Fig. 10. Succession of arbuscular mycorrhizal fungi and phosphate-dissolving microbes (PD) in plot Ⅳ-corn continuous system.

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Microbial Succession in Different Rotation Cropping Systems[1]

I. Fluctuations of VA Mycorrhizal Fungi and Phosphate-Dissolving Microbes

Chi-Guang Wu, Yen-Sher Liu, Shiuan-Yuh Chien and Tzean-Wei Tan[2]

Summary

Betweent 1993 and 1994, four different cropping systems, namely rice continuous, rice-corn rotation, corn-rice rotation, and corn continous cropping systems, were selected for the study of microbial succession. There were two fallow periods in these farming systems i. e. July-August and December-April. The vesicular-arbuscular mycorrhizal fungal (VAMF) spore production was maximal in the second fallow period. Weeds in the fallow field may play an important role in the spore production. Among the four cropping systems, corn continuous cropping system produced least spores and this was attributed to the high level of available phosphate in the soil. Totally, the production of VAMF spore in 1994 is less than in 1993.

In 1993, the populational growth of VAMF was negatively correlated with that of phosphate-dissolving microorganisms (PD) . This phenomenon was obvious in the first crop from March to July. In the second crop, negative correlation was also observed in the rice and corn continuous cropping systems. However, the other two systems showed another type of succession. In 1994, the population of VAMF and PD showed different patterns of fluctuations if compared with that of 1993.

The VAMF species was selected by the crops growing in different corpping systems. *Glomus mosseae* was highly correlated with the planting of rice. In the rotation or corn continuous cropping systems, *Glomus geosporum, G. manihots* and*Acaulospora elegans* were dominant species.

Key words : Microbial flora, vesicular-arbuscular mycorrhizal fungi, phosphate-dissolving microbes, succession.

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Mycorrhizal Association of *Glomus clarum* with Watermelon and Soybean[1]

Yung-Hsiung Cheng[2] and Chin-Chyu Tu[3]

Abstract: The growth of soybean was enhanced by the inoculation with *Glomus clarum* at the initial inoculum of 50 chlamydospores per plant. The invading hyphae of *G. clarum* produced appresoria on the root surface of watermelon and soybean at 5 and 9 days after inoculation, respectively. Following infection, the fungus colonized in cortex. Arbuscules were formed by repeated dichotomous branches of intracellular hyphae until they ended in a mass of fine hyphal branches occupying the cortical cells. Vesicles, which were usually intercellular, were found in cortical cells of watermelon 6 days after inoculation and reached abundance 2 days later. The external mycelium developed from the infection hyphae and produced spores at 10 and 19 days after inoculation of watermelon and soybean respectively. *Paspalum notatum* was suggested as a suitable host plant to increase inoculum of *G. clarum*, and the inoculum production could be as much as 13 times of the initial amount in 8 weeks after inoculation.

Key words: Watermelon, Soybean, Arbuscules, Vesicles, Endomycorrhiza *Glomus clarum*.

INTRODUCTION

Endomycorrhiza was first documented in the late 18th century[21]. Until the advanced experimental techniques were developed in the middle of 1950's, researchers began to study mycorrhizal fungi, and found the beneficial efficiency of these fungi to crops[2,10,11,12,18,22]. Gerdemann[10] indicated that endomycorrhizae were formed in 97% of infected plants. Mycorrhizal fungi were distrbuted worldwidely from North to South poles[10,17].

In the previous studies[3], we found that arbuscular mycorrhizal fungi were widely distrbuted in the soybean fields in Taichung, Huwei and Pingtung areas. The density of arbuscular mycorrhizal fungi in the fields was 5 to 148 spores per 200 gram of soils. The most common mycorrhizal fungus was *Glomus clarum* Nicol. & Schenck which sporulated abundantly in field in spring and autumn. The second was *Acaulospora laevis* Gerd.

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& Trappe in summer. *Gigaspora margarita* Becker & Hall, *Glomus mosseae* (Nicol. & Gerd.) Gerd. & Trappe and *G. macrocarpum* Tul. & Tul. were also occasionally isolated from soybean fields. The chlamydospores of *G. clarum* were transparent or dark yellow, spherical or ovary, and ranged from 85-250 μm (av. 150 μm) in diameter. The growth and pod production of soybean seedling infected by *G. clarum* increased[4,5]

In this study, we reported the infection process of *G. clarum* in soybean and watermelon, and studied the effective inoculum of this fungus for field applecation. Besides, suitable hosts for mass production of the inoculum of *G. clarum* were also suggested.

MATERIALS AND METHODS

1. Inoculum production of vesicular-arbuscular mycorrhizal fungus (VAMF)

Glomus clarum is the most prevalent VAM fungus distributed in the soybean fields in Taiwan. Chlamydospores of this fungus were collected by the method of wet sieving and decanting[9,13,20]. Soils with roots taken from the rhizospheres of well-growing soybean plants were homogenized in distilled water and followed by passing through 250-μm and 100-μm sieves. Materials retained on 60-μm sieves containing VAMF chlamydospores were resuspened in distilled water and examined under disecting microscope. After surface disinfection with 0.05% sodium hypochloride for 2 min and washed in sterile distilled water twice, chlamydospore suspension (200 spores per pot) was pippeted onto the roots of *Paspalum notatum* Flugge seedling grown in pot containing pasteurized sandy loam soils. Pot soil was autoclaved at 100°C for one hour previously. Controls were inoculated with the chlamydospores-free filtrates of *G. clarum*. Inoculated seedlings were then moved to greenhouse where the temperature was maintained at 24-30°C.

For examining mycorrhizae, roots taken from tested crops were washed and cut into 2 -5 cm long pieces. Root fragments were then heated on hot plate in 10% KOH solution at 95 °C for 3 min. After cooling, root fragments were rinsed with distilled water 3 times, and 10 min later, roots were immersed into 0.05% trypan blue in lactophenol for 2 hours. The destained roots by tap water were then examined by microscope[19]. Infection rates (%) were counted by examining 100 root fragments for each treatment.

2. Determination of the density of effective inoculum of *G. clarum* for host plants

This study was conducted in glasshouse at 24-30°C. Soybean seedlings (Tainon No. 15) used as test plants grew in pots (12 cm in diameter) containing sterile sandy loam soil. The sandy loam soil (pH 8.1) containing 0.64% organic matter, 366 Kg/ha P_2O_5 and 181 Kg /ha K_2O, was collected from an upland crop field at Kueilen, Tainan. The soil was pasteurized at 100°C for one hour before use. Each 5-day-old soybean seedling in one pot was inoculated with 50,100,200,400, 800, or 1600 chlamydospores of *G. clarum* into the rhizosphere soil, respectively. Six pots were used in each treatment. Controls were inoculated with chlamydospore-free filtrate. Seedling growth was measured weekly. After growth for 8 weeks, seedling roots were examined for the mycorrhizal formation.

3. VA mycorrhiza of *Glomus clarum*.

7-day-old seedlings of soybean and watermelon (Kinglan) were inoculated with 100

chlamydospores of *G. clarum* and transferred into a root-zone growth chamber at 28°C. Roots of seedlings were harvested daily and stained with lactophenol trypan blue to examine the infection procedure of VAM fungus.

4. Examination of VA mycorrhiza by scanning electron microscope

Mycorrhizal roots of soybean or watermelon seedling were cut into 5 cm pieces and then fixed, dehydrated, and coated by gold for ultrastructural observation following the procedures as described by Dewes[8]. Busch & Lomb scanning electron microscope was operated in this study.

RESULTS

Two-week-old seedings of *P. notatum* inoculated with *G. clarum* grew faster than controls (Fig. 6-A). Arbuscules and vesicles were formed in the cortex cells of host roots at 10 days after inoculation (Fig. 3 & 4). After inoculation for 8 weeks, chlamydospores of *G. clarum* increased to about 180 spores per 100 g soils as much as 13 times of the initial inoculum.

Results in Table 1 showed that *G. clarum* was effective in promoting plant growth and increasing pod yield of soybean Tainon No. 5 at the initial density of inoculum of 50 to 1600 chlamydospores per seedling. After inoculation for 8 weeks, the average height of soybean plants were 37.9, 39.5, 41.6, 39.2, 40.2, and 39.0 cm for treatments in which 50, 100, 200, 400, 800, and 1600 spores were inoculated respectively. The controls were 34.1 cm high in average. The root growth and biomass of mycorrhizal soybeans were also better and heavier than those of non-mycorrhizal controls. The average pods produced by mycorrhizal soybeans were 8 to 9, while non-mycorrhizal controls produced only 5 pods. Colonization rate for mycorrhizal plants were 38 to 57%.

Table 1. Effect of inoculum density of *Glomus clarum* on the growth of soybean [z]

Inoculum density of *G.clarum* (Spores/pot)	Average growth of soybean				% of root endomycorrhiza	Pods/plants
	Stem height (cm)	Stem weight (g)	Root length (cm)	Root weight (g)		
50	37.8 ab[y]	17.5 a	27.3 a	10.1 a	38	8.3
100	39.5 ab	17.1 a	27.5 a	10.6 a	42	9.6
200	41.6 a	19.0 a	28.5 a	11.1 a	52	9.8
400	39.2 ab	16.3 a	27.8 a	9.6 a	50	8.6
800	40.2 ab	16.9 a	28.6 a	10.5 a	51	8.7
1,600	39.0 ab	16.4 a	30.5 a	11.2 a	57	8.5
CK (0)	34.1 b	12.0 b	23.5 b	8.2 a	0	5.8

[z] Each value is the mean of 6 plants.
[y] Data with the same letter do not differ significantly at 5% level under Duncan's multiplerange analysis.

Some runner hyphae developed from germinating chlamydospores of *G. clarum* formed appressoria on the epidermal cells of watermelon roots at the 5th day of inoculation (Fig. 1-B). Penetration hyphae were observed to penetrate the epidermal cells directly or grow from the intercellular spaces to reach the cortex cells. After enter cortex cells, mycelia of *G. clarum* pentrated to 3 layered cells and moved parallely in cortex cells rapidly. Chains of arbuscules formed from repeated branching of intracellular mycelia were observed in longitudinal sections of roots (Fig. 3). The appressoria then produced infection hyphae penetrating epidermal cells and reached cortical cells. However, some of germinating hyphae directly penetrating epidermal cells without forming appressoria (Fig. 1-C). The intra- or intercullular hyphae of *G. clarum* then penetrated the adjacent cortex cells (Fig. 2-A). The hyphae of *G. clarum* within cortical cells were branched dichotomously and repeatedly, and eventually ended numerous finest hyphae (Fig. 2-B) which were called arbuscules [16] (Fig. 2-C,D). Some finest hyphae might expand into vesicles inside or between the cortical cells. Large amount of arbuscules (Fig. 3) and vesicles (Fig. 4) in the cortex cells were visible mostly at the 6th and 8th day of inoculation separately. Meanwhile, the external hyphae (Fig. 5) and chlamydospores were developed at the 10th day of inoculation (Fig. 5). At 6 days after inoculation, intracellular hyphae began to produce terminal vesicles. At the same time, the external hyphae grew out of the root cells and enter the rhizospheres to form mycelial mats. Chlamydospores were formed by the external hyphae at 10 days after inoculation (Fig. 5).

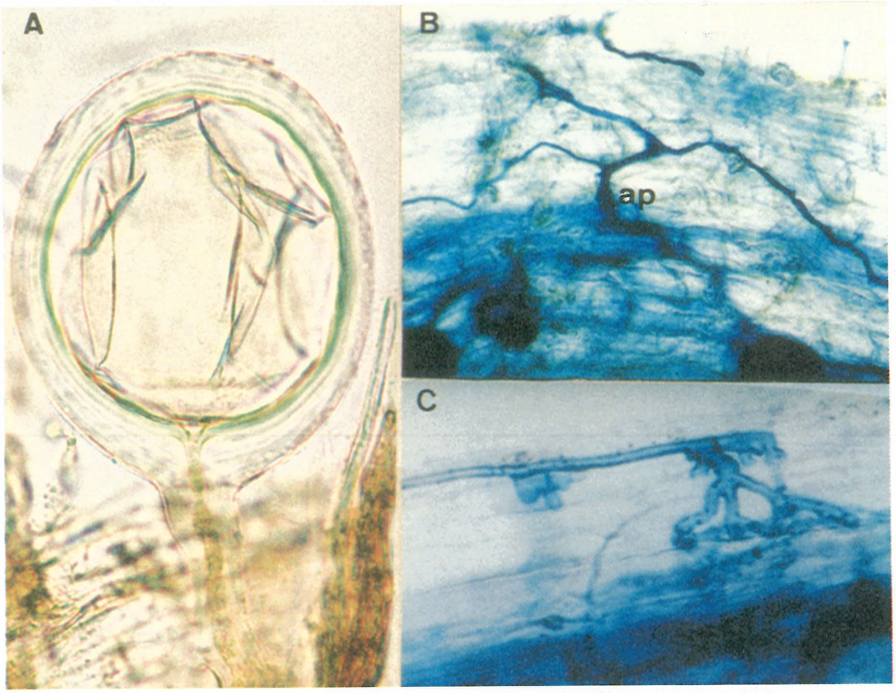

Fig. 1. The germinating chlamydospore penetrated through the cortex cells of watermelon. A. chlamydospore of *Glomus clarum*. B. Formation of appressorium (ap) at the infection site. C. Penetration of hyphae with branching.

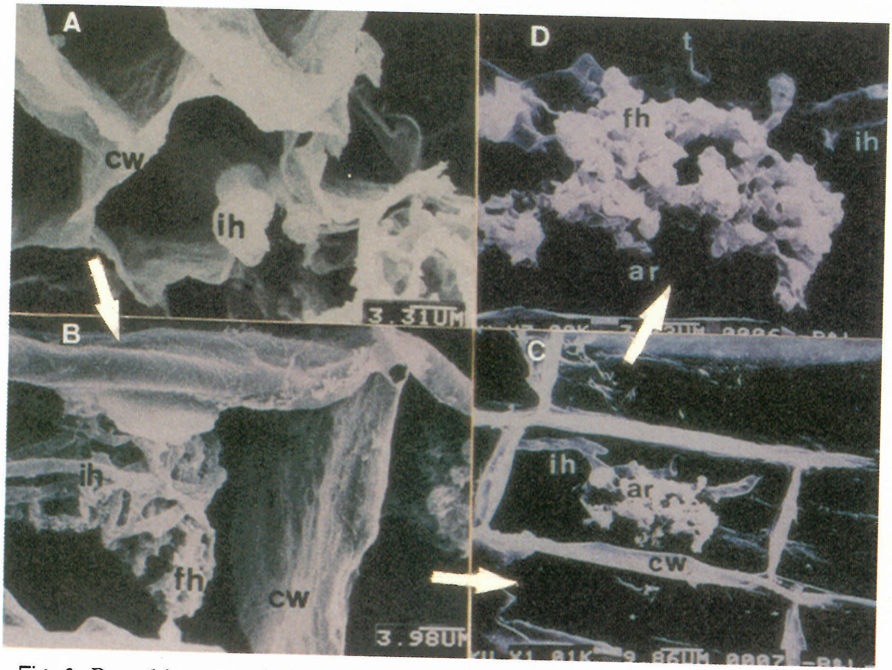

Fig. 2. Branching of intercellular hyphae and development of arbuscules (ar) of *Glomus clarum* in cortex cells of watermelon.

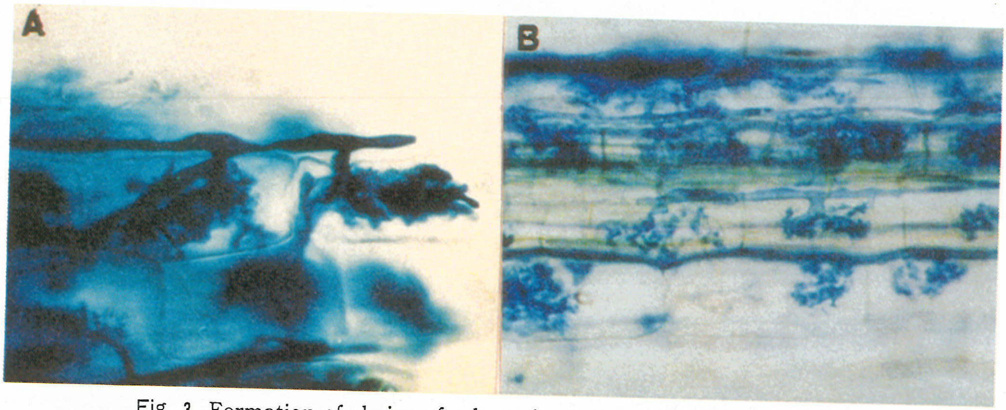

Fig. 3. Formation of chains of arbuscules in cortex cells of watermelon.

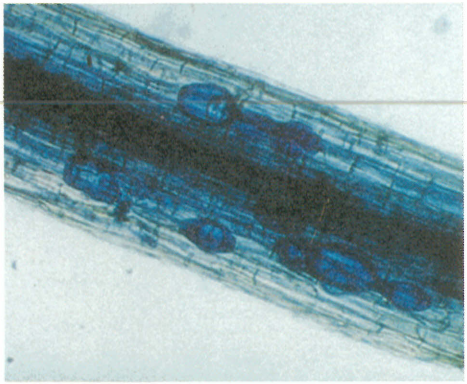

Fig. 4. Formation of vesicles in cortex cells.

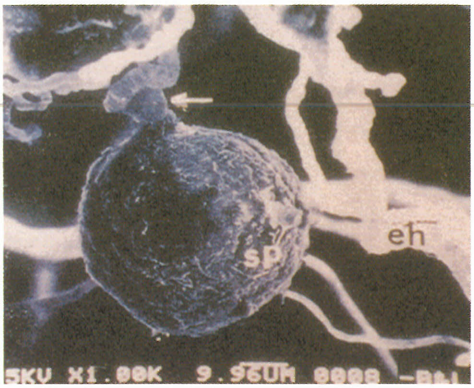

Fig. 5. Development of external hyphae and production of terminal chlamydospore.

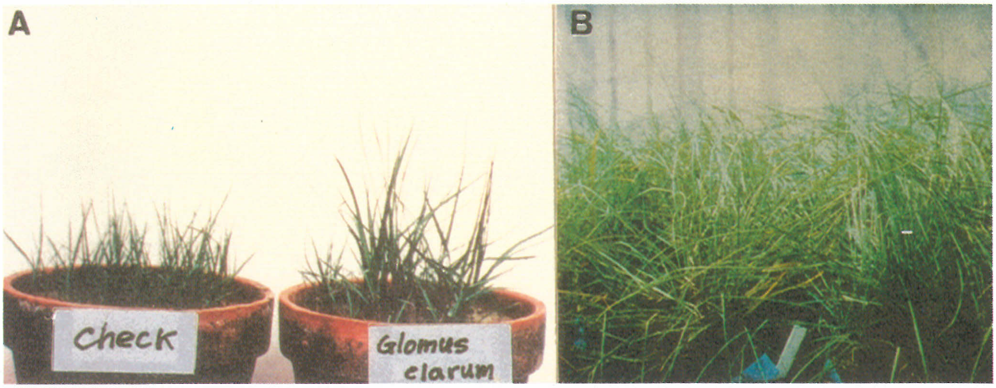

Fig. 6. Cultivation of *Glomus clarum* with bahia grass. A. Endomycorrhizal (Right) and nonmycorrhizal plants (left). B. Mass production of *Glomus clarum* in pot culture.

The infection process and mycorrhizal formation of *G. clarum* in soybean were similar to those in watermelon, but mycorrhiza developed slower in the former. In soybean, infection of *G. clarum* occurred at 9 after inoculation, arbuscules were formed in cortex cells at 11 days and vesicles were formed at 17 days. Fungus produced external hyphae and sporulated at 19 days. This result revealed that the same VAM fungus completed the infection and mycorrhizal formation in different speed when it infected different host plants. Whether it was easier for *G. clarum* to infect fleshy roots of watermelon than woody roots of soybean or some reasons else, it needed more researches to prove.

The mycorrhizal infection of *G. clarum* in soybean was similar to that of watermelon, but the infection process in soybean was longer than that in watermelon. The infection began at the 9th day of inoculation. Arbuscules and vesicles appeared in cortex cells at the 11th and 17th day, respectively, and chlamydospores produced by external hyphae were observed at the 19th day.

DISCUSSION

Vesicles in VA mycorrhizae were generally thought to work in capacity of nutrient storage and form chlamydospores for reproduction[1,7]. In early developing stage, vesicles contained diluted cytoplasm, several oil droplets and glycogen granules[14,15]. Following its development, cytoplasm became condensed and formed many spherical oil drops, which was similar to the contents of *G. clarum* chlamydospores. When vesicles were mature, they pressed against the cortex cells and finally destroyed the epidermal cells to expand out of roots. All of the developing procedures of vesicles were observed in our studies. The developing process of vesicles was thought to have close relations with chlamydospores formation[6].

Before VAM fungi are inoculated to certain crop, researchers would like to know the minial concentration of initial inocula which shows growth promotion effect to the crop. Effective density of inoculum was more important in short-term crops application than long-term crops. In this study, 50 chlamydospores per soybean seedling was enough for growth promotion. When primary inoculum increased up to 200 chlamydospores per plant, the efficacy of *G. clarum* on the seeding growth promotion could be demonstrated more significant. However, the growth promotion was not positively related to the inoculum amount.

Before the artificial media were developed, search for appropriate host plants and culture media for mass production of VAM inoculum are the most important works at this moment. *Paspalum notatum* is considered as one of good hosts for propagation of *G. clarum*. In this study, chlamydospores of *G. clarum* could be increased up to 13 times of the initial inoculum at 8 weeks after inoculation. Since *P. notatum* is a pleiocyclic rhizocarpous grass, it could be maintained in pots for long period.

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內生菌根菌 *Glomus clarum* 在西瓜、大豆之感染過程及菌根之形成[1]

程永雄　杜金池[2]

摘要

內生菌根菌（*Glomus clarum*）之接種源係採百喜草盆栽培養之土，以篩網傾注法來分離厚膜孢子。內生菌根產生有益效應之最初接種量（initial inoculum density）之決定，是於盆栽大豆進行孢子接種試驗，大豆之最初接種量以每棵50個孢子即能促進植株生長，而每棵接受200個孢子更顯著地的增加地上部及地下部之生長。內生菌根菌 *G. clarum* 之感染過程及菌根形成，分別以大豆及西瓜進行接種試驗，每日採集根部依組織透化法染色根段，以光學顯微鏡及掃描式電子顯微鏡調查眞菌之感染過程。在接種後五天西瓜根部表面上之內生菌根菌之孢子產生發芽管或侵入菌絲末端膨大形成吸盤（appressorium）再產生侵入菌絲，而大豆則在九天後才發生感染（28°C±2°C），侵入菌絲通常貫穿二層細胞，繼之在皮層細胞內發展形成叢枝狀體（arbuscules）。西瓜於接種後 6 天在皮層細胞間出現囊狀體（vesicles），至第 8 天出現多量之囊狀體，此時隨之發展根外之菌絲體，並於接種後第10天在外菌絲末端產生厚膜孢子，而大豆之內生菌根則存接種後第19天才產生厚孢子。

關鍵詞：西瓜、大豆、叢枝狀體、囊狀體、內生菌根菌。

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酸味種楊桃醃漬過程中有機酸及糖類變化之研究[1]

楊淑惠　王惠亮　王武彰[2]

摘要：楊桃在醃漬期間，其汁液之 pH 值無明顯變化，可滴定酸度（titratable acidity）在醃漬二週內由0.81g%降至0.48g%，但之後變化不大。新鮮楊桃汁之有機酸中的草酸（oxalic acid）與蘋果酸（malic acid）含量在醃漬初期分別由0.82g%及0.03g%降至0.31g%及0.02g%，而後變化不明顯；抗壞血酸（ascorbic acid）含量在醃漬初期亦明顯減少，二週後再緩緩回升。醋酸（acetic acid）在新鮮果汁中並不存在，醃漬至第二週後出現，其含量由0.03g%逐漸增至0.08g%。檸檬酸（citric acid）含量則不穩定。楊桃汁之糖類以果糖、葡萄糖爲主，蔗糖含量較少。果糖、葡萄糖含量在醃漬初期各減少57.7%及62.9%，自第二週後減少情形較緩和。粗蛋白質（crude protein）含量約在0.26g%，變化不大。胺基態氮（amino nitrogen）含量約爲18.3mg%，隨醃漬時間延長而逐漸下降至8.8mg%。

關鍵詞：酸味種楊桃、楊桃汁、醃漬、成分。

楊桃品種很多，甜味種供鮮食，有二林種、秤錘種等[2]，而加工果汁則以酸味種爲主，多屬本地種，全省栽植面積爲99.64公頃，產區甚爲分散且多零星種植，較主要之產地在彰化縣花壇、員林及芬園等地[12]。楊桃汁具清涼退火之功效（本草綱目，李時珍），長久以來在傳統飲料中佔有一席之地，而酸味種楊桃由於本身價格低廉，產量又多，很適於加工。國人對於醃漬楊桃汁的接受性很普遍，故其銷售面很廣，利潤頗高，因此不論是在傳統食品再出發的研究上或開拓外銷飲料上，都頗受注目。目前醃漬楊桃汁的製作大約分兩段，第一段大部分由中盤商或農戶自行醃漬製得原汁，再由中、大盤商論斤收購，第二段則由食品公司自中、大盤商購得原汁後，依自有配方調製、殺菌包裝製成成品後出售。侯等[8]指出，楊桃的有機酸以蘋果酸、草酸及琥珀酸爲主，而可滴定酸度及胺基態氮含量約爲0.22g%及10mg%[11]。王[3]之研究顯示，楊桃汁的有機酸則以草酸爲主，pH 值在醃漬過程中，不隨時間增長而變化，粗蛋白含量亦同。而胺基酸含量則隨醃漬時間增長而增加。由游等[10]研究顯示，楊桃汁中糖類組成，經殺菌及貯藏，部分蔗糖已轉化成果糖及葡萄糖，酸含量愈高者較有利於果糖及葡萄糖轉化。方[1]之研究顯示，以５％食鹽醃漬酸味種楊桃，可提高果汁香氣風味，並縮短發酵時間至二個月。惟一般農家之醃漬環境較差，若以低於７％食鹽醃漬則腐敗風險較高。本試驗以第一段加工製作爲主，以傳統方法醃漬製作楊桃汁，探討每階段的成分變化及縮短醃漬時間的可能性，以提供加工業者生產更高品質產品之參考。

材料與方法

一、試驗材料

以採自彰化縣花壇鄉的本地酸味種楊桃（*Averrhoa carambola* L.）爲試驗材料。

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二、試驗方法

㈠楊桃汁製作方法：

酸味種楊桃經洗滌、瀝乾後稱重，將整顆楊桃平鋪在圓桶內，灑上一層鹽，鹽的總重爲楊桃總重的 8 %，如此一層楊桃一層鹽，最後覆上蓋網，並壓上重物，以便汁液滲出時，不致使楊桃浮出液面，避免感染雜菌。總計醃漬三個月，醃漬期間每二星期取樣一次（共六次），每個處理重複三次，進行成分分析[3,13]。

㈡分析項目：

供試驗分析之楊桃汁，除了新鮮楊桃汁是從新鮮楊桃壓榨而得，其後之楊桃汁皆取自醃漬後自然滲出汁液。

1. pH 值：自然滲出之楊桃原汁，經離心後取澄清液以 Jenco Model 6007之 pH meter 測定。
2. 酸度測定：取5g 樣品加10倍去離子水，加入酚酞指示劑以0.1N氫氧化鈉滴定至溶液呈粉紅色[4]，以g%草酸表示。
3. 抗壞血酸測定：以 Indophenol method 進行[7]，取5ml 偏磷酸，加入2g 樣品，以2,6-Dichlorophenol indophenol-Na 溶液滴定呈淡粉紅色後計算之。
4. 有機酸分析：新鮮楊桃汁及楊桃滲出汁液，經離心以 0.45μm 濾過膜處理後，以 Varain 2,550高效液相層析儀分析，分離管 Alltch ECONOSIL C18 10U, 250mm x4.6mm，UV 偵測器：220nm，流動相：0.01M 磷酸二氫鉀加 1 %甲醇，流速0.6ml/min. 溫度：室溫（26°C）。
5. 糖類分析：樣品處理同有機酸分析，分離管爲 Varain NH2, 300mm x 4.0mm，PHILIPS RI 偵測器，流動相爲：氰甲烷／水＝75/25(v/v)，流速：1.0ml/min.。
6. 粗蛋白質測定：以凱氏氮分析法分析(7)。
7. 胺基態氮測定：依中國國家標準 CNS 總號1260方法分析[4]。
8. 草酸含量測定：依 Boehringer Mannheim 公司之 biochemical analysis and food analysis 方法[14]。
9. 阿拉伯糖含量測定：以 Bial's reaction 方法進行分析，取樣本溶液1ml，加入沸騰 Bial 試劑 4ml，若樣品含五碳糖溶液即成藍綠色[5]。
10. 風味品評：由品評人員（共12人）試飲後紀錄分析其器評結果。品評標準爲 1 分：很差 2 分：差 3 分：尙可 4 分：好 5 分：很好。

結　　果

一、酸類變化

本試驗以彰化縣花壇鄉所採之本地種酸味楊桃爲原料，經洗滌、稱重、加 8 %食鹽醃漬三個月，每二週取滲出液進行成分分析。試驗結果顯示，醃漬楊桃的pH 值在醃漬期間的變化不大，如圖 1 所示，鮮果汁的 pH 值爲1.9，至第十二週爲 pH2.0。圖 2 爲酸度在醃漬期間的變化，醃漬初期酸度會很快由0.81g%降至0.45g%，而後則變化不明顯，此情況與 pH 值變化不相同。新鮮酸味種楊桃的有機酸主要爲草酸（0.82 g%），少量蘋果酸（0.03g%），檸檬酸（0.06g%）及琥珀酸（0.05g%），以草酸含量佔84.9%最多，圖 3 爲高效液相層析儀分析圖。經醃漬後的楊桃汁有機酸含量變化頗爲複雜，除草酸及蘋果酸分別降至0.30g%及0.01g%外，在草酸之前並多出一支面積頗大的波峰，如圖 4 所示，二週後隨著時間延長含量變化不大。爲確認草酸變化，本試驗並用“boehringer mannheim”公司的 biochemical analysis food analysis 之 oxalic acid 試劑測試，結果如表 1，顯示草酸含

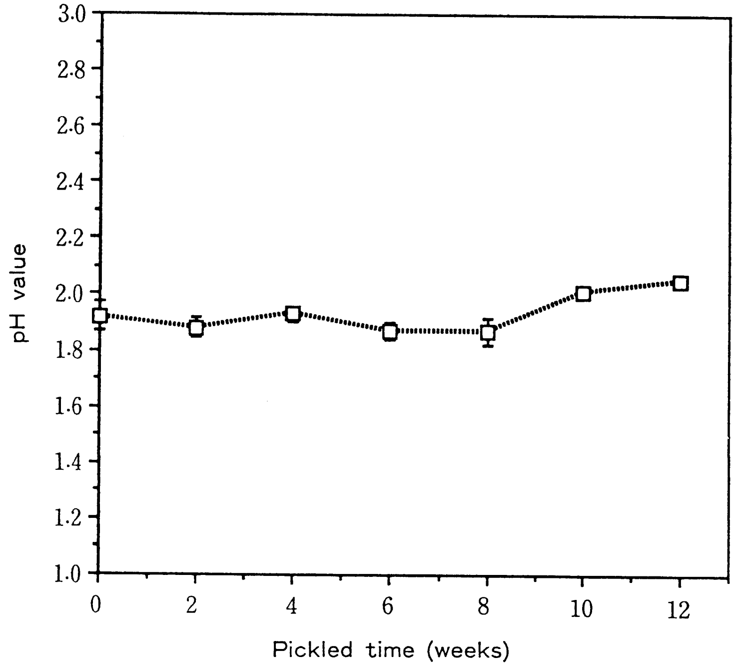


圖1. 楊桃醃漬過程中 pH 值之變化

Fig. 1. Changes of pH value of carambola juice during the pickled process.

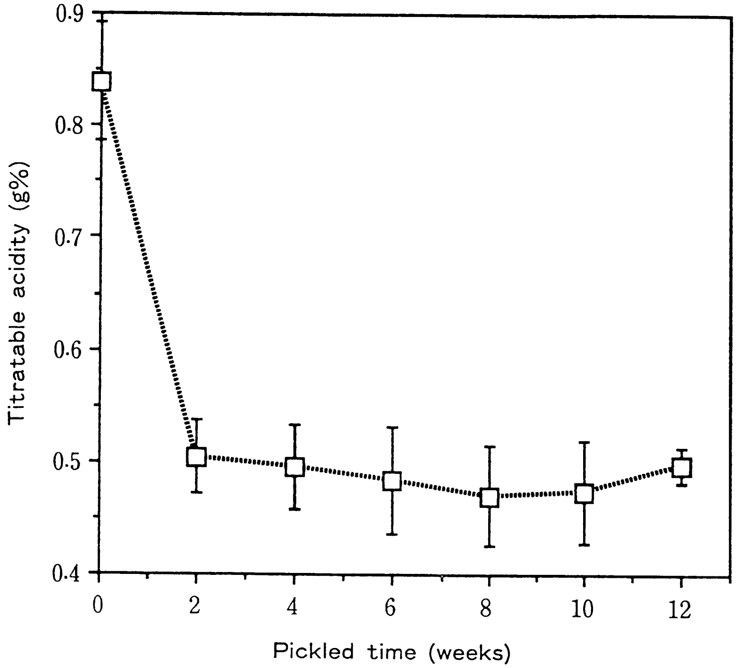
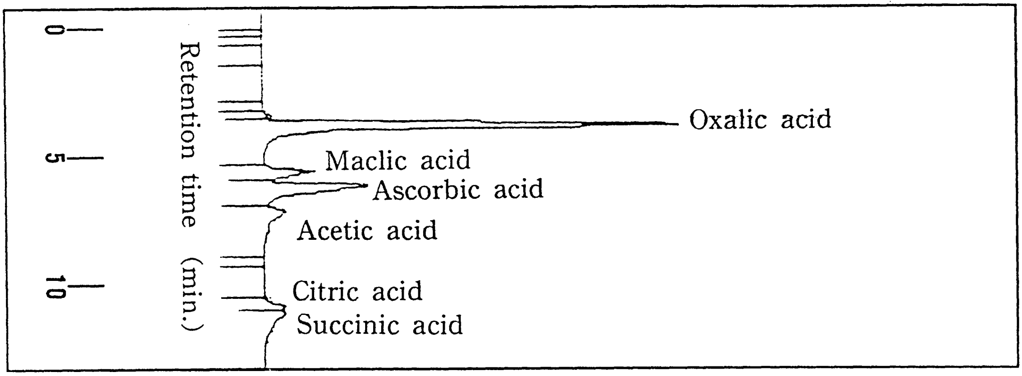
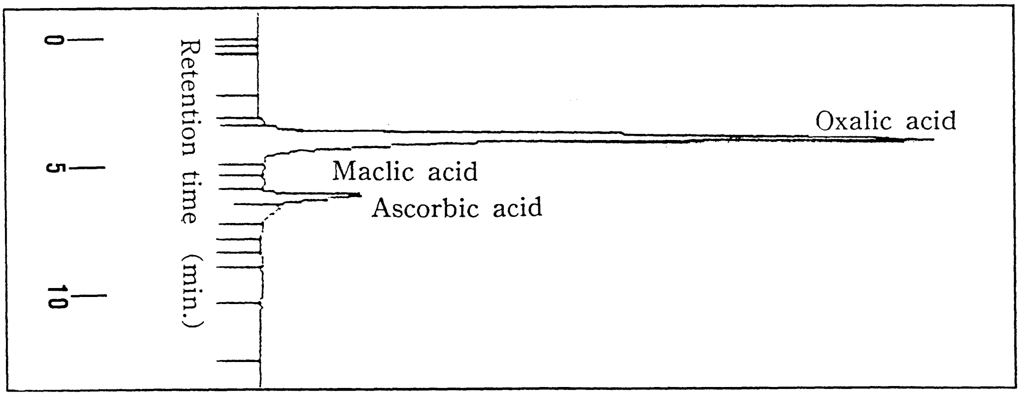


圖2. 楊桃醃漬過程中酸度之變化

Fig. 2. Changes of titrtable acidity of carambola juice during the pickled process.



標準酸類 (Standard of sugar)



新鮮楊桃汁 (Fresh carambola juice)

圖3. 標準及新鮮楊桃汁有機酸之高效液相層析圖
Fig. 3. HPLC profile for organic acids of standard and fresh carambola juice.

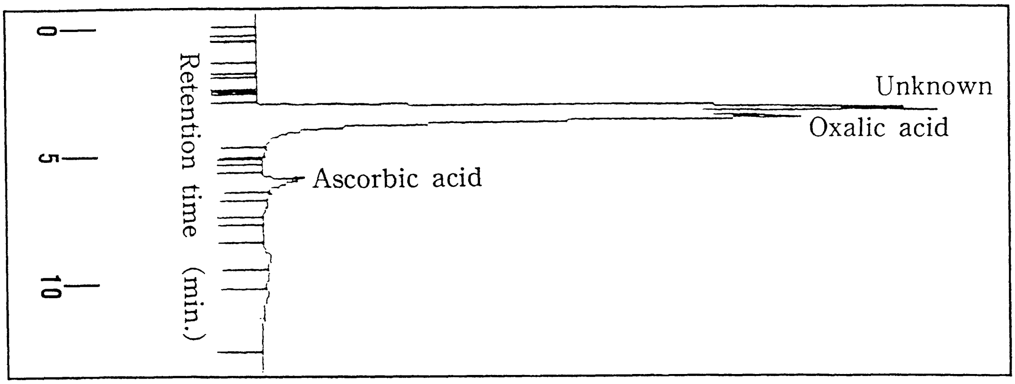


圖4. 醃漬二週後滲出液有機酸之高效液相層析圖
Fig. 4. HPLC profile for organic acids of exudate produced after 2 weeks pickling.

表1. 以高效液相層析儀及 UV-Method分析草酸在醃漬期間的含量變化
Table 1. Changes of Oxalic acid content analyzed by HPLC and uv-method during the pickled process.

Method of analyzed	Time of Pickling (weeks)						
	0	2	4	6	8	10	12
HPLC (%)	0.79	0.29	0.31	0.30	0.31	0.31	0.31
UV-mdthod(%)	0.83	0.31	0.30	0.31	0.32	0.32	0.32

量爲下降。醋酸爲鮮果汁中不存在的酸類，經醃漬二週後約有0.03g%產生，隨醃漬時間延長其含量增加至0.08g%，雖然醋酸未如預期呈現明顯上升趨勢，但仍顯示醃漬過程中存在著產醋酸的菌種，（在醃漬期間未測出乳酸之產生）。檸檬酸在醃漬過程中呈上下變動的不穩定狀態，含量範圍爲0.06 g%至008g%，琥珀酸經醃漬後已很難測出，如圖５所示，但總酸變化則大致與可滴定酸度變化一致。抗壞血酸在醃漬初期有很明顯減少的趨勢，由13.3mg%降至3.0mg%，隨後逐漸回升至8.0mg%左右（圖６）。

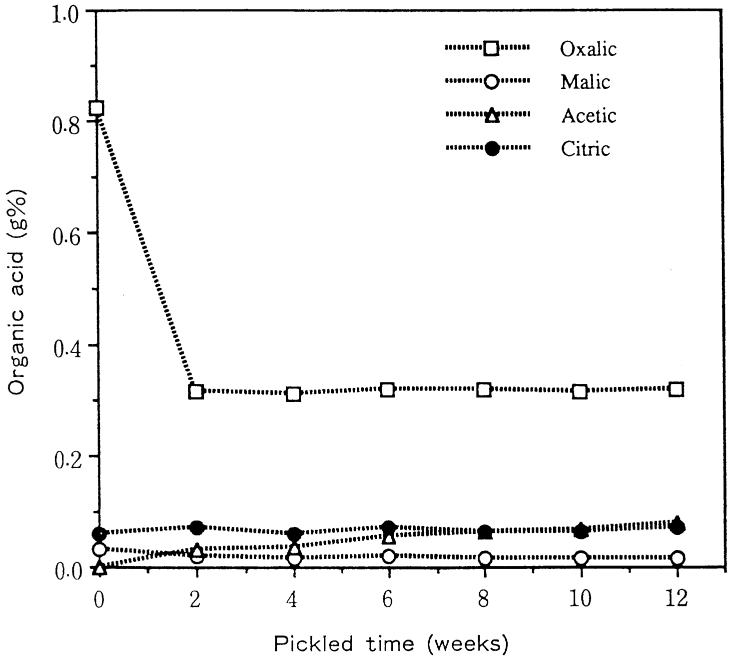


圖5. 楊桃醃漬過程中有機酸含量變化
Fig. 5. Changes of organic acid of carambola juice during the pickled process.

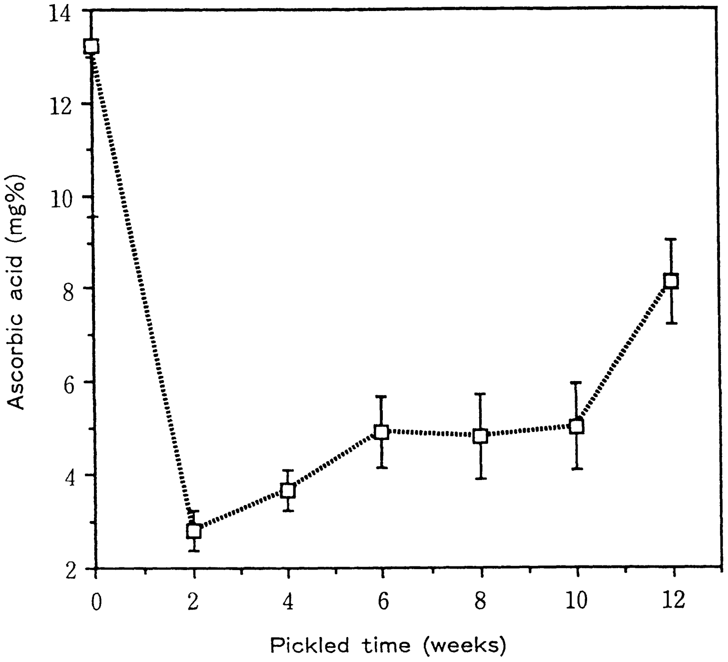
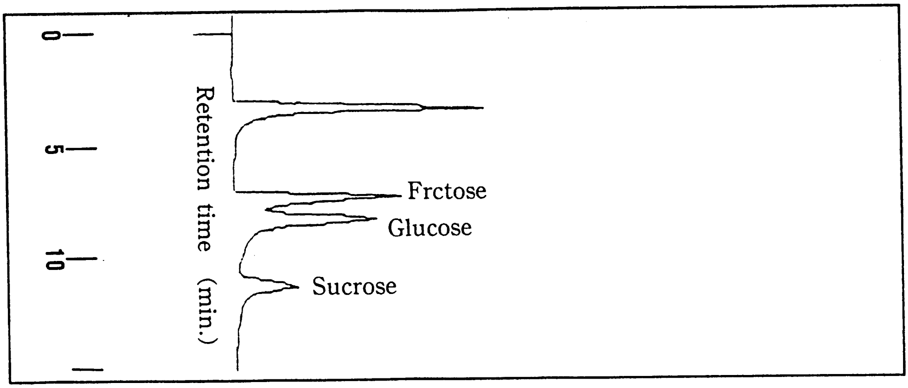


圖6. 楊桃醃漬過程中抗壞血酸含量之變化

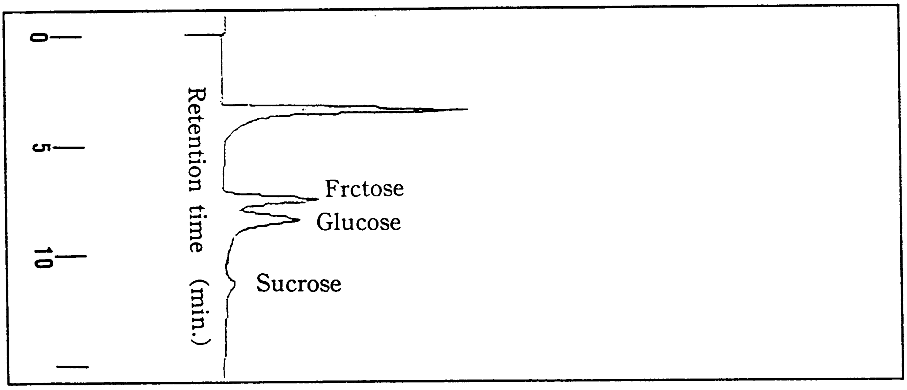
Fig. 6. Changes of ascorbic acid of carambola juice during the pickled process.

二、糖類及其他成分變化

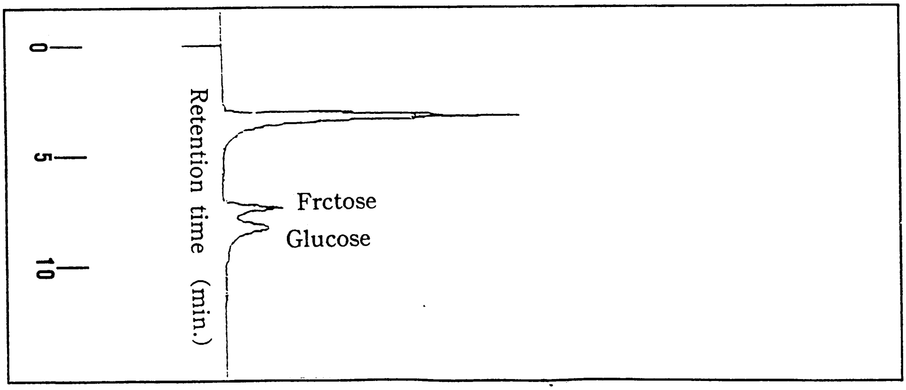
酸味種楊桃的糖類以果糖（含量約1.95g%）及葡萄糖（1.25g%）爲主，蔗糖含量較少（0.21g%），在醃漬的前二週，滲出液中的糖類含量會有較明顯的減少，含量分別爲0.83g%（減少57.7%）及0.3g%（62.9%），蔗糖含量則無法測出，以高效液相層析儀分離結果如圖7，隨著醃漬期間延長糖類含量亦緩緩下降，圖8爲其含量變化情形，酸味種楊桃的粗蛋白質（crude protein）含量約0.26g%，醃漬期間含量變化不明顯（圖9）。胺基態氮（amino nitrogen）含量在鮮果汁時爲18.3mg%，經醃漬後則漸漸下降爲8.8mg% 如圖10所示。



標準糖類 (Standard of acids)



新鮮楊桃汁 (Fresh carambola juice)



滲出液 (Exudate produced)

圖7. 標準、新鮮楊桃汁及滲出液糖類之高效液相層析圖

Fig. 7. HPLC profile for sugars of standard、fresh carambola juice and exudate produced after 2 weeks pickling.

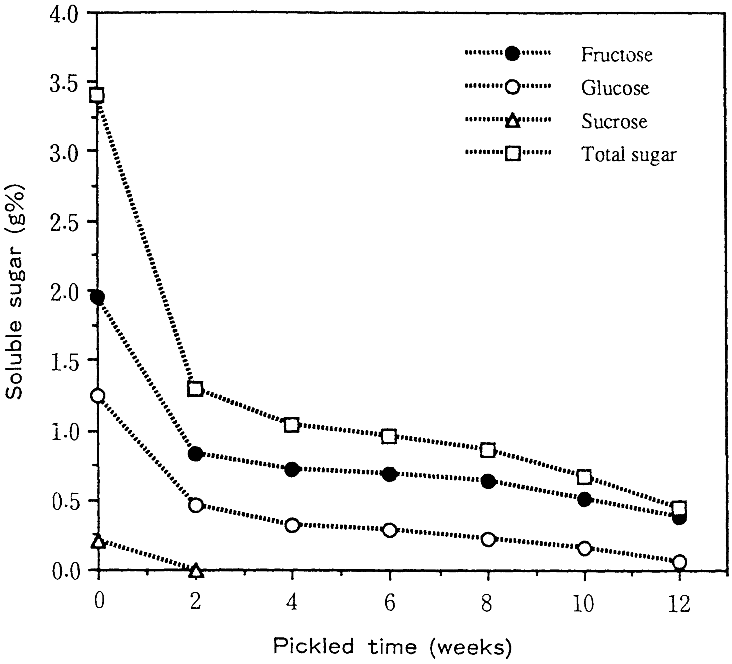


圖8. 楊桃醃漬過程中可溶性糖含量變化

Fig. 8. Changes of soluble sugar of carambola juice during the pickled process.

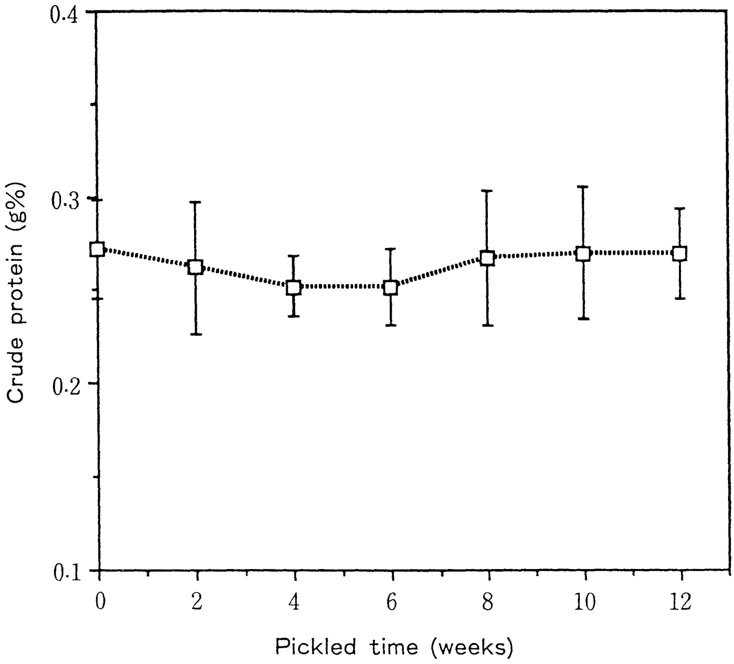


圖9. 楊桃醃漬過程中粗白質含量變化

Fig. 9. Changes of curde protein of carambola juice during pickled process.

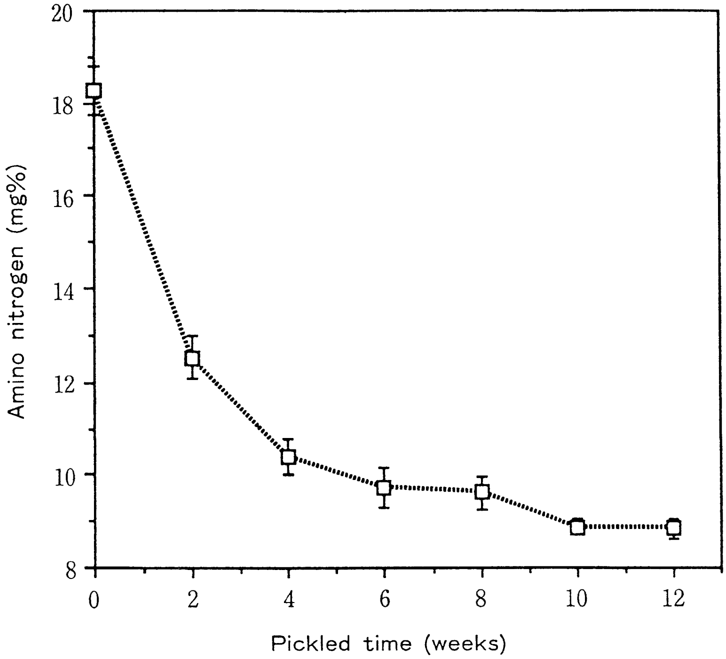


圖10. 楊桃醃漬過程中胺基態氮含量變化

Fig. 10. Changes of amino nitrogen of carambola juice during pickled process.

三、官能品評

品評樣品分爲三組，第一組：四至六週原汁總糖量0.73%、酸度0.4%、鹽量4.5%，第二組：七至八週原汁總糖量0.28%、酸度0.35%、鹽量5.1%，第三組：十至十二週原汁總糖量0.16%、酸度0.31%、鹽量5.9%，供品評之楊桃汁爲楊桃原汁以一比四比例加糖液（12°Brix）製成稀釋果汁，第一組品評爲3.7分，楊桃香味濃郁、有鹹味，第二組爲3.0分風味尙可、鹹味太重，第三組品評爲2.5分風味略差、鹹味太重。

討　論

一般醃漬楊桃汁的調製方法爲原汁加糖液稀釋（1：4）而成，主要風味除了醃漬所產生的自然香氣外，加糖調製後酸酸甜甜略帶鹹味的口味亦是醃漬楊桃汁的重要特點，這與楊桃原料加0.5—1.0%鹽，鹽醃1－2天，再加水打汁加糖、酸等副原料而成的稀釋楊桃汁[10]風味不同，尤其以甜味種楊桃製成的楊桃汁，由於酸度較低（0.22g%），若製成20%稀釋果汁勢必依賴人工酸味料之添加，提高酸度[9]，酸味種楊桃在醃漬期酸度雖有減少，仍保持在0.45g%左右，由於 pH 值仍然頗低（pH 2.0），故一些會導致食品腐敗的微生物很難生長，因此經三個月醃漬仍不致腐敗，且經加糖液稀釋後糖酸比例仍佳。酸味種楊桃不適宜鮮食的原因除了酸度太高不合口外，草酸含量太高（約0.82g%）、澀味太重亦是重要因素。本試驗所測之有機酸種類以草酸爲主，與王氏[3]、游氏[10]之分析相近，而侯氏等[8]及 Campbell[15]之研究，楊桃有機酸以蘋果酸含量最多，草酸次之，琥珀酸最少略有不同，此可能是品種不同所致。本試驗結果中顯示， 醃漬後楊桃草酸含量會降至0.30g%左右與鮮食甜味種相近[7]，此結果與黃氏等[8]之報告，在發酵香蕉飲料試驗中，草酸等有機酸含量會減少的情形

相似。依王氏[3]之報告，以「傳統方法醃漬」後草酸含量增加，而「改良式（接菌產膜酵母）楊桃汁」之有機酸變化中草酸含量減少，推測是醃漬環境不同，生長微生物種類不同所致，可能是本試驗醃漬過程中則亦是以「產膜酵母」較多，詳細情形有待進一步鑑定。酸味種楊桃汁在醃漬過程中 pH 值一直保持穩定，而有機酸及酸度會上下變動的情況不同，應爲滲出液中存在著具緩衝力的物質，本試驗以 HPLC 分析醃漬後的楊桃滲出液，在草酸之前會多出一段面積頗大的波峰，此波峰可能爲鹽（已證實非葡萄糖酸[3]），另將各有機酸依分析比例單獨或混合泡製時發現，標準草酸0.8g%時pH1.6，含量0.4g%時 pH1.8。其他酸類含量均較少，pH 在2.8至3.3左右，草酸含量高時混合泡製對 pH 影響不明顯，唯草酸含量少時則反使 pH 略升。抗壞血酸在醃漬初期含量明顯降低，可能是受氧化而分解形成糠醛[17]所致，而隨後的醃漬過程中，抗壞血酸含量逐漸增加，可能是菌類（如 *Acetobacter ranscens*、*Cluconobacter roseus*等）等作用而合成[6]，詳細情形有待繼續探討。醃漬過程中糖含量逐漸減少，初期可能是被利用於自身代謝菌體繁殖，後期則可能是被利用於合成其他酸類[16]。另依王氏[3]之報告，以傳統方式醃漬楊桃汁會產生７－８g%阿拉伯糖，但改良式楊桃汁則無阿拉伯糖產生，在本試驗以 HPLC 及 Bial’s reaction（orcinol test）及經修改之 Summer 變化[5]等呈色法均無法測得阿拉伯糖，推測亦是因生長菌種不同所致。在本試驗的各項成分除粗蛋白質外，均以第二週的變化最大，而後的變化則很有限，這顯示醃漬初期微生物處於「對數期」，生菌數大量增加，能量消耗較多，而後的「定常期」則能量消耗較少。在三個月的醃漬期間，以第四至第六週的楊桃汁香氣較佳，除鹹味重外，各成分變化也大都穩定，此顯示該發酵已近完成階段，唯滲出量較少（約總收重75%），影響實際收益，如何改變原料處理或以加入果膠方式，增加滲出量，及有效改善醃漬環境，期能減少食鹽用量則有待繼續研究。

在我國加入關貿總協（GATT）之後，國外各種東汁相繼進口，很可能會減弱省產果汁的競爭力，而醃漬楊桃汁是屬於本土性飲料，佔有地區性優勢且楊桃汁長久以來亦一直是消費者所喜愛的傳統飲品之一。但傳統醃漬法因菌種自然消長繁殖，品質、風味不穩定，亦無法一貫作業。以篩選菌種[1]直接加入的發酵方法可否爲業者接受，如何培育低草酸、低酚類、又含高糖度及高酸度的品種，以增進果汁風味等問題則有待研究人員及育種專家繼續努力。

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Studies on the Changes of Organic Acid and Sugar Content of Carambola during Pickled Process[1]

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Summary

Tart carambola fruits were pickled with 8% salt by a traditional method for three months. The exudate were taken and analyzed in every two weeks during the pickled process. The results showed that the pH value changed insignificantly during the pickled process. Titratable acidities decreased from 0.81g% to 0.48g% in the beginning two weeks, and did not change a lot in the following picked days. Oxalic and malic acid contents also decreased from 0.82g% and 0.03g% to 0.30g% and 0.02g%, respectively in the beginning 2 weeks, but didn' t change a lot in following pickled days. Ascorbic acid content decreased significantly from 13.3mg% 3.0mg% in the begining 2 weeks and then gradually increased up to 8.0mg%. Acetic acid appeared after pickling for 2 weeks, and increased from 0.03g%to 0.08g% during pickling. Citric acid showed unstable content from 0.06%to 0.08%. Frcutose and glucose contents sharply rdeuced 57.7% and 62.9%,respectively, after the first two weeks and then became palliatively. The crude protein content sustained about 0.3% showed not much change during the pickled process, however amino nitrogen content decreased from 18.3mg% to 8.8mg%.

Key words : Tart carambola variety, Birne pickling, Components.

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螺旋粉蝨為害損失與防治[1]

溫宏治[2]　許洞慶[3]　陳秋男[4]

摘要：螺旋粉蝨持續爲害聖誕紅35天時，爲害率與爲害度分別爲98%及82%，持續48天時全株葉片枯萎而喪失觀賞價值。爲害番石榴植株如連續達 4 個月時，爲害葉率可達64%，果實產量損失爲80%。卵經浸藥法比較藥效，以2.8% Bifenthrin EC 2,000倍殺卵效果最佳。經田間 8 種藥劑試驗結果，以 90% Methomyl WP 1,800倍防治若蟲效果最佳。成蟲以藥液乾膜法測試，經處理後24小時以 90% Methomyl WP 1,800倍處理者存活率最低，各藥劑處理成蟲經48小時後大致死亡。低毒類物質試驗中，以 50% Neem oil 200倍混合 Triton 3,000 倍防治效果最佳。以水速12.5公升／分作噴水處理，每二天噴一次，連續進行一個月，對若蟲防治率可達78.5%，成蟲爲86.4%。

關鍵詞：螺旋粉蝨、爲害損失、防治、*Aleurodicus dispersus.*

螺旋粉蝨（*Aleurodicus dispersus* Russell）自1988年首度於臺灣省高雄縣大寮鄉被發現後，迅速擴散，次年傳播至鳳山、楠梓、屏東市等地，1991年北至北港，南至恒春，東至臺東地區皆有其蹤跡，1992年往北蔓延至南投、草屯地區，1993年侵入臺中縣及花蓮縣，至1994年臺北市亦被發現（溫等，未發表），又從溫度對本蟲發育之試驗結果顯示全臺灣之溫度條件均可容許本蟲之生存[(1)]。至今在本省，此蟲之寄主植物既有記錄者有64科144種[(2)]，唯隨著該蟲之蔓延及適應性之增強，寄主植物之種類數勢必增加。此蟲族群在無有效天敵之環境下增加甚速，每到新地區便造成相當大的受害，受害植株片萎凋、乾枯及掉落[(4,7)]。加上，在美國佛羅里達州，曾記錄傳播可可椰子之致死毒素病（Lethal yellow virus）之可能性[(5,12)]。有關該蟲之防治，在美國夏威夷州曾引進二種寄生蜂及三種捕食性瓢蟲，而將此蟲控制[(6,11)]。沙勞越以 9 種藥劑進行番石榴上本蟲之防治試驗，效果顯著，減少果實之受害[(8)]。本文針對此蟲在番石榴及聖誕紅之爲害損失及防治試驗結果加以探討，以提供對該蟲發生時防治之參考。

材料與方法

一、爲害損失調查

(一)聖 誕 紅

本試驗處理分保護組及未保護組，未保護組係將20株聖誕紅置入有螺旋粉蝨發生之美人蕉圃內，任螺旋粉蝨自由產卵爲害，然後每 7 日觀察聖誕紅之被害情形，記錄每盆聖誕紅之葉數

1. 臺灣省農業試驗所　研究報告 1786 號。
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（包括處理前）、被害葉數及 2、3 齡若蟲及蛹之總蟲數，為被害葉率及被害度之數據。被害度則據 Vanisham 及 Kogam[10] 於大豆粉蝨（*Trialeurodes abutiloneus*）取樣時所採用的如下四個等級：

1＝無被害株。2＝植株具少數蟲體但被害輕微。3＝中度被害且葉面沾有蜜露。4＝大多葉片已發生煤病。然後依下列公式計算被害度（Degree of infestation）。

$$被害者（\%）=\frac{\Sigma（等級\times 該等級被害株數）}{4\times 調查株數}\times 100$$

保護組則另設20盆聖誕紅於網室內，隔絕螺旋粉蝨之為害，同時進行相同調查。觀賞度則請 6 位工作人員對植株進行目視觀察，並如下三等級記分：△正常、▲不雅及▲▲惡劣。此後以下列公式評定

觀賞度（%）＝3×△＋2×▲＋1×▲▲/N×100

並將觀賞度90%以上者列為正常(normal)，71—89%為不雅(ugly)，70以下為惡劣(bad)。

㈡番 石 榴

選定 1～2 年生網室盆栽及 4～5 年生露地栽植，大小略等之番石榴植株分別進行試驗。試驗組分為每 7 天（完全防治）或14天（一般防治）撒佈稀釋1,800倍之90%納乃得可濕性粉劑一次及不防治共 3 處理，採逢機完全區集設計。每一處理組番石榴 3 株，重複 4 次，即 3 × 4 × 3 ＝36株。又在試驗前一天，摘除株上果徑大於 1 公分之果實。連續處理 4 個月後每株逢機調查10個枝條，記錄枝條上之總葉數、被害葉片數及 2、3 齡若蟲及蛹之總蟲數，並採下植株上所有果實稱其重量。產量損失則依下列公式計算。

$$產量損失（\%）=\frac{完全防治區之產量－一般或無防治區之產量}{完全防治區之產量}\times 100$$

二、防治試驗

㈠殺卵試驗

以含卵之美人蕉苗為試驗材料，另配製 2.8% Deltamethrin（Decis）EC 1,000倍、10 % Permethrin（Kestrel）EC 1,000倍、25% Carbosulfan（Marshal）WP 1,000倍、2.8 % Bifenthrin（Talstar）EC 2,000倍、90% Methomyl（Lannate）WP 1,800倍等藥液及水等，另加一無浸液之對照組共 7 處理，每處理 2 株× 4 重複共56株，如此測定各供試藥劑之藥效，浸苗前先記錄苗上之卵數，經浸苗 3 秒，涼乾蕉苗，置於室內逐日觀察卵之孵化。

㈡對若蟲之防治試驗

以番石榴為供試作物，處理組有 2.8% Deltamethrin EC 1,000倍、50% Omethoate（Folimate）SL 1,000倍、10% Permethrin EC 3,000倍、90% Methomyl WP 1,800倍、2.8% Bifenthrin EC 2,000倍、50% Malathion EC 1,000倍、5 % Fluythrinate EC 3,000倍、25% Carbosulfan WP 1,000倍及不施藥組為對照區，田間採逢機完全區集設計，每一處理番石榴 2 株，重複 4 次，即 2 株× 9 處理× 4 重複＝72株。每10天以背囊式噴霧器均勻噴施一次，共施藥二次。第一次施藥前及第二次施藥後之第10、20及30日調查取樣每株之25片中、老葉，記錄葉片上成活之若蟲數，以如下公式計算防治率。

$$防治率（\%）=（1-\frac{處理區施藥後活蟲數\times 對照區處理前活蟲數}{處理區施藥前活蟲數\times 對照區處理後活蟲數}）\times 100$$

分析方法：所得資料經變方分析後，如處理間差異顯著，則依鄧肯氏多變域測驗法分析各處理間之差異顯著性，顯著機率（P.S.）爲 5 %。

㈢對成蟲之防治試驗

以美人蕉爲供試作物，處理組有 2.8% Deltamethrin EC 1,000倍、10% Permethrin EC 2,000倍、25% Carbosulfan WP 1,000倍、2.8% Bifenthrin EC 2,000倍、90% Methomyl WP 1,800倍與不施藥等 6 處理，每處理美人蕉 3 株，4 重複共72株。將藥液噴於美人蕉苗上，待蕉苗上之藥液涼乾後，各苗株個別置入雙口玻璃筒中。於24小時後每株蕉苗上接入50隻成蟲，接蟲24及48小時後記錄死亡成蟲數。從此計算供試藥劑之防治率。

㈣利用低毒性物質之防治試驗

以番石榴爲供試作物，處理組有 49% M-pede L 50倍（皀脂類），49% M-pede L 50倍混合 Triton、50% Neem oil 200倍（苦楝種子萃取物）、50% Neem oil 200倍混合 Triton、Washing powder（白蘭牌）1,000倍、Washing powder 1,000倍混合 Triton、Cleaning agent（藍寶牌）1,000倍、Cleaning agent 混合 Triton、Triton（均用3,000倍）及不施藥組共10處理。採逢機完全區集設計，每處理番石榴 2 株，重複 4 次，即 2 株×10處理× 4 重複＝80株。每 7 天以背囊式噴霧器均勻噴施一次，共施藥 4 次，每次施藥前及最後一次施藥後第 7 天取樣每株之10片中、老葉，記錄葉片上成活之若蟲數。從此計算供試藥劑之防治率。

㈤噴水之防治效果

試驗分爲以每分鐘12.5公升之水速噴水於番石榴葉背處理組及無噴水之二處理。每處理 5 株，重複 4 次，採逢機完全區集排列，每 2 天處理一次，連續處理 4 週，處理前及處理期間每週每株逢機取樣一次25片中、老葉，記錄葉片上成活之成蟲及若蟲數，與同前公式計算防治率。

結果與討論

一、爲害損失調查

㈠聖 誕 紅

民國80年 3 月20日將盆栽聖誕紅放入螺旋粉蝨嚴重發生之美人蕉圃內，讓粉蝨成蟲自由飛來產卵爲害，結果如表 1，第一週調查時葉片上所發現者以卵爲主，尚對葉片之外觀不構成爲害，第14日調查時，部份若蟲已孵出，開始吸食葉片，分泌蜜露引起煤病，被害葉率已到38.6%，被害度爲27.6%，第21天調查時，大多數卵已孵化，且部份若蟲已進入蛹期，此時被害葉率提高至62.5%，被害度爲35.7%，煤病之發生也加重。第28天調查時，被害率增至80.6%，被害度爲64.7%，此時全株約在1/3之葉片上發生煤病。至第35天調查時之被害率達97.6%，全株葉片上均發生煤病，並粘覆一層銀灰色粉末，每株葉片數由原先之45片減至38片而漸失觀賞價值。至第42天調查時，葉片益加乾脫落。第48天葉片已枯萎脫落，每株只剩21片因而完全喪失觀賞價值。於保護組第48天調查時，每株平均具76.3枚葉片，與被害株之間有顯著性差異，由此亦知螺旋粉蝨對聖誕紅之爲害及所引起之損失甚爲迅速。

表1. 螺旋粉蝨爲害不同天數時對聖誕紅之損失調查

Table 1. Damage on poinsettia caused by *Aleurodicus dispersus* at different days after infestation

Days	Leaves[z] /plant		Leaves[z] infested (%)		Degree of infestation (%)		Appearance	
	A[y]	B[y]	A	B	A	B	A	B
0	43.5bc	42.5 a	0.0 a	0.0	0.0	0.0	Normal	Normal
7	45.2 c	45.4ab	0.0 a	0.0	0.0	0.0	Normal	Normal
14	47.4 c	48.6 b	38.6 b	0.0	27.6	0.0	Normal	Normal
21	46.3 c	52.5bc	62.5 c	0.0	35.7	0.0	Ugly	Normal
28	45.5 c	58.1 c	80.6 d	0.0	64.7	0.0	Ugly	Normal
35	38.4 b	63.6 c	97.6 e	0.0	82.4	0.0	Bad	Normal
42	30.2ab	70.2cd	100.0 e	0.0	92.8	0.0	Bad	Normal
48	21.5 a	76.3 d	100.0 e	0.0	95.4	0.0	Bad	Normal

[z] Means in each column followed by the same letters are not significantly different at 5% level according to Duncan' s Multiple Range Test.
[y] A : Non-protected ; B : Protected.

㈡番 石 榴

本試驗於80年 2～6 月以 1～2 年生盆栽番石榴植株進行初步試驗。同年10月至次年 1 月於田間以 4～5 年生植株進行第二次試驗，此時以不同施藥間隔及無施藥處理，比較螺旋粉蝨對番石榴之爲害率及果實產量之影響，從此估計所引起之損失量。試驗結果如表 2 ，在每 7 天施藥時，無論 1～2 或 4～5 年生番石榴植株未發現被害葉，每株單期果實產量分別爲2.94及9.46公斤，以每公頃500株計算，4～5 年生植株每公頃之產量爲4,730公斤。在每14天施藥之處理區，1～2 及 4～5 年生被害葉率分別爲5.12%及9.33%；植株之果實產量分別爲2.78及8.83公斤，4～5 年生植株每公頃之產量爲4,415公斤。無處理組 1～2 及 4～5 年生被害葉率分別爲52.14%及76.22%；植株之果實產量分別爲0.78及1.92公斤，4～5 年生每公頃產量僅960公斤，與每 7 天施藥區比較其產量損失，分別爲73.46%及79.70%。然此爲僅 4 個月未予防治所得之結果。若以螺旋粉蝨雌蟲於25°C在番石榴之平均產卵量51.28粒(溫等未發表)計算，經 4 個月後蟲數至少增加31,250倍，如此任其任其爲害一年以上，對果實損失必然更大，或許毫無收獲可言。

表2. 螺旋粉蝨之爲害對番石榴產量之影響

Table 2. Yield loss of guave infested by *Aleurodicus dispersus*[z]

Treatment[y]	Leaf infested (%)		Wt. of fruit (Kg/plant)		Yield loss (%)	
	A[x]	B	A	B	A	B
1. 7day	0.00a[w]	0.00a	2.94a	9.46a	0.00a	0.00a
1. 14days	5.12a	9.33a	2.78a	8.83a	5.65a	6.66a
3. Check	52.14b	76.22b	0.78b	1.82b	73.46b	79.70b

[z] Other pest or disease was not counted in this table.
[y] Chemical was sprayed at 7 and 14 days interval.
[x] A : 1—2 years old plant, B : 4—5 years old plant.
[w] Means in each column followed by the same letters are not significantly different at 5% level according to Duncan's Multiple Range Test.

二、防治試驗

(一)殺卵試驗

利用美人蕉苗供螺旋粉蝨產卵後，將卵連同蕉苗於室內經浸藥處理後，記錄卵之孵化情形，結果如表3，以 2.8% Bifenthrin EC 2,000倍之殺卵效果最佳，平均殺卵率爲 97.13%，90% Methomyl WP 1,800倍次之，殺卵率爲93.87%，2.8% Deltamethrin EC 1,000倍亦佳，殺卵率爲90.56%，而 10% Permethrin EC 2,000倍及 25% Carbosulfan WP 1,000倍稍差，殺卵率分別爲77.47%與70.96%，僅浸水處理時之死卵率5.61%。由此推斷田間施藥防治本蟲時，儘量噴濕被害部位，使藥液盡量長時間沾附於卵之外表或蠟粉上，如此或許有助於提高殺卵效果，降低本蟲之發生。

表3. 螺旋粉蝨之卵藥劑防治試驗
Table 3. Chemical control of eggs of *Aleurodicus dispersus*

Treatment	No. of survival eggs		Mortality
	Pre-treatment	Post-treatment	(%)
1. Deltamethrin 2.8% EC 1,000X	1,074	86	90.56 c[z]
2. Permethrin 10% EC 2,000X	816	156	77.47 b
3. Carbosulfan 25% WP 1,000X	978	241	70.95 b
4. Bifenthrin 2.8% EC 2,000X	908	22	97.13 c
5. Methomyl 90% WP 1,800X	770	40	93.87 c
6. Water	1,317	1,055	5.61 a
7. Check	945	802	0.00 a

[z] Means in the different letters are significantly different (p=0.05) according to Duncan's Multiple Range Test.

(二)對若蟲之防治試驗

在田間利用番石榴植株評估8種殺蟲劑對螺旋粉蝨若蟲之防治效果如表4。以 90% Methomyl WP 1,800倍防治效果最佳，經二次施藥後第4、10、20及30日之防治率分別爲93.60%、95.59%、81.80%及71.11%；其次爲 5% Fluythrinate EC 3,000倍，防治率各爲93.34%、93.63%、88.24%及66.67%，再次爲 25% Carbosulfan WP 1,000倍防治率各爲94.81%、93.63%、85.03%及57.78%，此三種藥劑經20日仍可維持80%以上之防治率，其他測試藥劑至第10日效果均良好，唯至第20日後其殘效漸下降，如 10% Permethrin 3,000倍於第10日防治率爲92.95%，至第20日降至3.20%。

表4. 番石榴螺旋粉蝨若蟲藥劑防治試驗

Table 4. Chemical control of *Aleurodicus dispersus* of nymph on guava from December 1989 to January 1990.

Treatment	No. of nymphs/25 leaves (%control)				Avg. control (%)
	4 DAT[y]	10 DAT	20 DAT	30 DAT	
1. Deltamethrin 2.8% EC 1,000X	10.74 a[z] (88.55 a)	10.25 a (87.55 a)	11.75 b (74.86 ab)	4.75 ab (57.78 ab)	77.18
2. Omethoate 50% SL 1,000X	7.88 a (91.62 a)	12.38 a (84.98 a)	4.50 a (90.37 a)	6.13 ab (45.51 b)	78.12
3. Permethrin 10% EC 3,000X	11.00 a (88.28 a)	5.80 a (92.95 a)	48.25 c (3.20 c)	17.75 b (0 d)	46.11
4. Methomyl 90% WP 1,800X	6.00 a (93.60 a)	3.38 a (95.59 a)	8.50 a (81.80 a)	3.25 a (71.11 a)	85.52
5. Bifenthrin 2.8% EC 2,000X	9.25 a (90.15 a)	11.00 a (86.65 a)	19.00 b (59.36 b)	7.25 ab (35.56 bc)	67.93
6. Malathion 50% EC 1,000X	3.75 a (96.01 a)	7.13 a (91.36 a)	15.25 b (67.38 ab)	9.13 ab (18.84 c)	68.39
7. Fluythrinate 5% EC 3,000X	6.25 a (93.34 a)	5.25 a (93.63 a)	5.50 a (88.24 a)	3.75 a (66.67 a)	85.47
8. Carbosulfan 25% WP 1,000X	4.88 a (94.81 a)	5.25 a (93.63 a)	7.00 a (85.03 a)	4.75 ab (57.78 ab)	82.81
9. Check	93.88 b (0 b)	82.38 b (0 b)	46.47 c (0 c)	11.25 ab (0 d)	0.00

[z] Means in each column followed by the same letters are not significantly different at 5% level (Duncan's Multiple Range Test).

[y] DAT : Days after treatment.

(三)對成蟲之防治試驗

利用藥液乾膜試驗法，將成蟲接入筒內之蕉苗上，觀察成蟲之存活，試驗結果如表 5，經24小時後之觀察，以 90% Methomyl WP 1,800倍之防治率為最高94.08%，10% Permethrin EC 2,000倍次之，為92.61%。2.8% Deltamethrin EC 1,000倍最差，僅57.18%。唯至48小時觀察時，所有處理組的成蟲大致死亡殆盡。即該粉蝨成蟲對所有參試藥劑之感受性極強，若果在田間噴施此等藥液時，應可殺死多數成蟲，而減少其產卵機會。

表5. 螺旋粉蝨成蟲藥劑防治試驗

Table 5. Chemical control of adult of *Aleurodicus dispersus*[z]

Treatment	Before treatment	No. of adults (%Control)	
		24 HAT[y]	48 HAT
1. Deltamethrin 2.8% EC 1,000X	50	17.40b[z] (57.18)	3.80a (88.89)
2. Methomyl 90% WP 1,800X	50	2.40a (94.08)	0.20a (99.41)
3. Malathion 25% WP 1,000X	50	3.80a (90.64)	1.40a (95.90)
4. Carbosulfan 25% WP 1,000X	50	3.80a (90.64)	1.00a (97.07)
5. Permethrin 10% EC 2,000X	50	3.00a (97.61)	0.80a (97.66)
6. C. K.	50	40.60c (------)	34.20b (------)

[z] Means in each column followed by the same letters are not significantly different at 5% level according to Duncan's Multiple Range Test.

[y] HAT : Hours after treatment

(四)利用低毒性物質之防治試驗

於番石榴上撒佈 5 種低毒性物質時，對螺旋蝨若蟲之防治效果如表 6。就單劑而言以 49% M-pede L 及 50% Neem oil 之防治效果較佳，平均防治率分別爲63.18%及67.17%，Washing powder 及 Cleaning agent 效果不佳，平均防治率分別爲49.19%及45.61%。就每種單劑中混合 Triton（出來通）展著劑時，均能顯著提高防治效果。其中，以 50% Neem oil 混合 Triton 防治效果最佳，平均防治率爲82.26%。49% M-pede L 與 Washing power 分別與 Triton 混合時平均防治率分別爲78.69%及76.09%，效果稍差。49% M-pede L、50% Neem oil 分別加入展著劑防治馬鈴薯粉蝨，對其若蟲體有去蠟的物理作用(3,9)。故在安全考量下，50% Neem oil 更適合防治一般家庭栽植之花卉上發生之粉蝨。

表6. 低毒物質防治螺旋粉蝨試驗

Table 6. Efficacy of controlling *Aleurodicus dispersus* on guava by low toxic substance

Treatment[z]	No. of nymphs/20 leaves (%control)					Avg. control(%)
	Pertreat	Application				
		1st	2nd	3rd	4th	
1. 49%M-Pede L 50X	225.6	219.3 (44.1)	103.2 (74.3)	115.9 (70.6)	93.3 (63.7)	63.18 b[y]
2. 49%M-Pede L 50X + Triton	202.5	70.1 (80.1)	82.2 (77.2)	72.4 (79.5)	71.5 (78.0)	78.69 a
3. 50%Neem oil 200X	209.2	122.9 (66.5)	118.1 (68.3)	74.3 (79.7)	155.2 (54.2)	67.17 b
4. 50%Neem oil 200X +Triton	236.2	82.3 (80.0)	70.4 (83.2)	60.3 (84.2)	70.3 (81.6)	82.26 a
5. Washing powder (白蘭) 1,000X	149.4	135.2 (39.8)	126.4 (52.5)	152.3 (58.5)	127.8 (47.4)	49.49 c
6. Washing powder 1,000X+Triton	258.6	175.5 (62.2)	80.7 (82.4)	134.5 (75.9)	70.3 (83.1)	76.09 a
7. Cleaning agent (蘭寶) 1,000X	170.5	141.2 (44.0)	168.4 (44.7)	152.6 (30.5)	101.4 (63.3)	45.61 c
8. Cleaning agent 1,000X+Triton	285.2	125.2 (74.6)	155.8 (69.4)	136.2 (75.6)	146.2 (55.1)	68.68 b
9. Triton	182.4	263.4 (28.5)	263.2 (29.7)	251.5 (22.3)	242.4 (21.5)	20.51 c
10. Check	210.4	336.7 (0)	374.2 (0)	336.8 (0)	340.3 (0)	0 d

[z] Triton was diluted 3,000 times.

[y] Means followed by the same letters are not significantly different at 5% level (Duncan's Multiple Range test)

(五)噴水之防治效果

以每分鐘流量12.5公升之噴水處理，每隔 2 天噴水番石榴葉。如此連續四週時，對螺旋粉蝨之防治結果如表 7。由原先每10葉平均74.4隻成蟲數減少至10.8隻，此時之防治率爲86.4%。就若蟲而言，則由每10葉125.7隻減少至22.8隻，防治率78.5%。顯見噴水處理對該粉蝨族群之增長有抑制效果。蓋噴水處理可破壞保護若蟲外層之蠟粉，影響其生長或因蟲體之暴露易受天敵之捕食及體內水份之喪失。且每次噴水會招致大量成蟲及卵粒落地死亡，不但有直接防治效果，而且可減少成蟲產卵之機會。故長期之噴水處理不失爲一種安全有效抑制方法。

表7. 螺旋粉蝨噴水抑制試驗

Table 7. Efficacy of controlling *Aleurodicus dispersus* by spraying water on guava (1991，11—12)

Treatment[z]	No. of nymphs/10 leaves (% control)					
	Before	Weeks after treatment				
	Pre-treat	1st	2nd	3rd	4th	Mean[y]
Nymphs						
Spraying	125.7	95.7	60.3	32.7	22.8	52.9a
Water		(28.7)	(51.9)	(70.9)	(78.5)	
Check	146.5	156.5	145.1	130.8	124.2	139.2b
		(0)	(0)	(0)	(0)	
Adults						
Spraying	74.4	42.3	20.7	19.6	10.8	23.3a
Water		(49.7)	(77.9)	(73.9)	(86.4)	
Check	66.7	75.5	84.3	67.4	71.6	74.7b
		(0)	(0)	(0)	(0)	

[z] Water velocity：12.5 l/min.
[y] Means in the column with different letters are significantly different (p=0.05) according to Duncan′s Multiple Range Test.

綜合以上的試驗結果，得知聖誕紅不經防治時約20天後會影響觀賞價值，因此配合其卵期需要訂定害蟲的管理策略。以 Methomyl 防治番石榴上之螺旋粉蝨時，每 7 天或14天噴灑一次，應不致引起明顯的減產，然考慮防治成本，以14天之噴藥一次爲佳。在化學藥劑中 90% Methomyl WP 對卵、若蟲及成蟲皆有較佳的防治效果。在低毒物質處理時，以 50% Neem oil 加展著劑 Triton 之效果較好。噴水可去除部份成蟲及破壞若蟲外層之腊粉，使粉蝨更易受到環境抵抗之影響而降低其發生量。

誌　謝

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Yield Loss and Control of Spiralling Whitefly (*Aleurodicus Dispersus* Russell)[1]

Hung-Chich Wen[2], Tung-Ching Hsu[3] and Chiou-Nan Chen[4]

Summary

The infestation rate and degree of infestation were 98% and 82% when poinsettia was consecutively attacked by spiralling whiteflies for 35 days. And most of leaves were chlorosis, withered, covered with sooty mold and appeared premature dehiscence on day 48 which made them lost their commercial value. If whiteflies attack guava for consecutive 4 months, the leaf infestation rate reached 64% and caused 80% fruit yield loss.

Various synthetic chemical and non-chemical insecticides were tested in this experiment to control spiralling whitefly. Results indicated that 2.8% Bifenthrinate EC 2,000X gave the best eggs control among eight insecticides tested. However, 90% Methomyl WP 1,800X was more effective for nymphs in the field trial. Significant higher adults mortality was shown when treated with 90% Methomyl WP at the first 24 hours in residual film test, however, all adults died after 48 hours no matter which insecticide was applied. In low toxic substance treatment, 50% Neem oil 200X mixed with Triton 3,000X gave the best control rate. Water spraying at the rate of 12.5 l/min. and 2 days interval for consecutive 1 month was able to control 78.5% of nymphs and 86.4% of adults.

Key words : *Aleurodicus dispersus,* Spiralling whitefly, Infestation, Control.

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臺灣為害經濟植物之葉蟎種類及12種殺蟎劑對二種主要葉蟎之毒性測試[1]

何琦琛　羅幹成　陳文華[2]

摘要：1991～1993年調查臺灣爲害平地主要經濟植物葉蟎，共發現九種，常見者有七種。以神澤氏葉蟎（*Tetranychus kanzawai* Kishida）出現頻率最高，爲害植物種類最多；其次爲二點葉蟎（*T. urticae* Koch）；僞二點葉蟎之出現頻率、爲害植物數及分布均與赤葉蟎相當，重要性顯較習知者爲高；柑桔葉蟎（*Panonychus citri*（McGregor））因一般未取樣山坡地作物而出現頻率偏低；荔枝葉蟎（*Oligonychus litchii* Lo et Ho）及皮氏葉蟎（*T. piercei* McGregor）之出現頻率較前五種葉蟎爲低。室內測試12種殺蟎劑推廣濃度對採自9地區7種作物上之神澤氏葉蟎及二點葉蟎之毒性，50% formetanate S.P. 及30% dinobuton E. C. 對二種葉蟎均表現出穩定之毒效，68.1% propargite E. C. 對部份地區之二點葉蟎有效，並對各地區之神澤氏葉蟎均有效。對神澤氏葉蟎有效者尙有2.8% cyhalothrin E. C. 、20% amitraz E. C. 、25% bromopropylate E. C. 及 35% Venthene W. P.。

關鍵詞：經濟植物、葉蟎、藥劑毒性。

葉蟎爲臺灣之重要經濟害物（pest），爲害農作物、觀賞植物、行道樹等等，往往發生甚高之密度，或影響收成、或影響樹勢，造成重大損失。在許多農作物上尙且是主要之害物，須特別予以防治[1,2,3,5,6,8,9,11,12]。在不同經濟植物上發生爲害之葉蟎種類，多未經正式調查鑑定。已有調查之經濟植物中，所報導之葉蟎種類亦不周全。何琦琛和陳文華[3]報導在臺灣茄園爲害之葉蟎類不止植物保護手册中所記載之二點葉蟎（*Tetranychus urticae* Koch）一種，且有地域性之不同。過去記載爲害木瓜之葉蟎爲赤葉蟎（*T. cinnabarinus* Boisduval）[8]，但近年來木瓜園所採得葉蟎中赤葉蟎所占比率卻不高（羅幹成、未發表資料）。造成此現象之另一種可能原因爲田間葉蟎相有所變遷，例如1978年以前爲害草莓之葉蟎以神澤氏葉蟎（*T. kanzawai Kishida*）爲主，其後逐漸被二點葉蟎取代[11]。

不同種類之葉蟎對農藥之感受性常有差異，因而防治之對策亦須不同。在從事植保工作時，所面對之葉蟎究爲什麼種類乃成爲須予了解之事項，筆者等因而調查在臺灣爲害經濟植物之葉蟎種類。此外，殺蟎劑對葉蟎之防治效果，往往因農民用藥習慣不同而在不同地域有差異。推薦有效藥劑予農民時，常因而遭逢挫折。是以在調查葉蟎種類時，亦同時對此現象試爲探討，測試常用推廣殺蟎劑對不同地點、作物上葉蟎之毒效。披露所得結果於本文，提供相關工作同仁參考。

材料與方法

自1991年起至1993年止，每2—3月爲一循環，前往臺中、南投、彰化、雲林、嘉義等地之主要經

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濟植物田中，於四個角落及中央部位選取有葉蟎爲害狀之葉片，攜回實驗室，以 Hoyer's medium 將葉蟎之成蟎製成玻片標本，鑑定種類。並記錄雌成蟎數，供同時發生兩種葉蟎時比較主要發生之種類。此外並商請桃園區農業改良場、花蓮區農業改良場、臺東區農業改良場、臺中區農業改良場、臺南區農業改良場及農業試驗所鳳山分所之植物保護同仁於其轄區內依相同方法採取主要經濟植物上發生葉蟎之葉片，郵寄予筆者等，將葉蟎製做標本鑑定種類。

此外，並就最常發生之神澤氏葉蟎及二點葉蟎測試12種市售不同類型殺蟎劑之推廣濃度對其毒性。將田間採回之葉蟎，挑取雌成蟎依 Lee et al.[13]之法以青皮豆苗飼育。而後將吳子淦[4]之方法略爲修改，在直徑約4.5cm之培養皿中，以飽吸水份之棉花代替洋菜膠，以青皮豆代替十石大豆。每葉片挑入葉蟎20隻，以 Burkard Spray Tower 噴洒1ml 之溶於水之推廣濃度殺蟎劑藥液，觀察記錄72小時後之死亡率；四重覆。此外，因農民施藥時常加重劑量，故亦以同法測試推廣濃度四倍劑量時對葉蟎之毒性。

結果與討論

1992～1993兩會計年度中，採取了907個樣品，加上桃園區農業改良場等六試驗場所提供者，總共自93種經濟植物採取1,298個樣品。除澎湖縣及苗栗縣外，其餘各縣均涵蓋在調查範圍中，各縣所採取之樣品數及所包含之經濟植物種類數依序列於表 1 。農試所之取樣調查範圍僅及臺中、臺南、彰化、雲林及嘉義等五縣，其餘各縣端賴各場所協助取樣調查。

表 1. 各縣所採樣品數、經濟植物種數及七種主要葉蟎採得頻率

Table 1. The number of samples, crops and the collecting frequency of 7 spider mites from each county.

County	No. of samples	No. of crops	OL	PC	TC	TK	TP	TT	TU
Taipei	12	2			1	1			10
Taoyuan	3	3					3		
Hsinchu	1	1				1			
Taichung	169	37	24	16	9	45	1	1	26
Nantou	252	52	11	16	18	85	14	5	32
Changhwa	289	43	1	6	30	63	1	29	85
Yunlin	152	28	3	10	7	63		5	33
Chiayi	45	28				17		15	
Tainan	16	9			3	3		2	
Kaohsiung	109	11	17	30	8	24	2	16	11
Pintung	118	11	1	29	1	74	2	9	
Taitung	42	10		2		19	3	5	
Hwalien	7	6			1	3		2	
Ilan	83	14				6		2	

OL : *Oligonychus litchii*
PC : *Panonychus citri*
TC : *Tetranychus cinnabarinus*
TK : *T. kanzawai*
TP : *T. piercei*
TT : *T. truncatus*
TU : *T. urticae*

全部樣品經鏡檢後在83種經濟植物（89%），935個樣品（72%）內發現有葉蟎爲害。其中 6 樣品上有*Oligonychus*屬葉蟎爲害，123樣品上有 *Tetranychus* 屬葉蟎爲害，但缺乏雄性成蟎，無法鑑定種類。其餘樣品中鑑定出 9 種葉蟎，分別爲荔枝葉蟎（*Oligonychus litchii* Lo et Ho）、*O. shinkajii* Ehara, *O. uruma* Ehara、柑桔葉蟎（*Panonychus citri*（McGregor））赤葉蟎、神澤氏葉

蟎、皮氏葉蟎（*T. piercei* McGregor），僞二點葉蟎（*T. truncatus* Ehara）、二點葉蟎（表 2）。而主要發生者僅 7 種，神澤氏葉蟎最爲常見，其出現頻率最高，在31.1%的樣品（404個）中發現；寄主種類也最多，53種經濟植物上發現有此蟎爲害。其次爲二點葉蟎，在15.2%之樣品（197個）33種經濟植物上採得。赤葉蟎及僞二點葉蟎出現率（6%，78樣品及7%，91樣品）雖略低於柑桔葉蟎（8.4%，109樣品），但爲害植物種類數（25種經濟植物）較柑桔葉蟎（18種經濟植物）多，分布亦極寬廣。羅幹成和趙若素(10)曾調查僞二點葉蟎之寄主植物記錄有33種，但此蟎在臺灣一直未受重視，不當成經濟害蟎。本次調查很驚訝地發現，它的出現率及爲害植物種類數均高於赤葉蟎，使其經濟重要性大爲提高，將來應列爲防治之對象。荔枝葉蟎出現率爲4.4%，在57樣品 9 種經濟植物上採得。皮氏葉蟎之出現率爲 7 種中最低者（2%），在26樣品11種經濟植物上採得，筆者認爲尙須獲得更多資料，以判斷其是否具經濟重要性。其餘之葉蟎僅出現一次，重要性遠遜於上述 7 種。

表 2. 各葉蟎種類之出現頻率、百分比及寄主植物數

Table 2. Frequency and percentage of presence, and the number of hosts of various spider mites.

Species	Frequency	Percentage	No. host
O. litchii	57	4.4	9
O. shinkajii	1	0.0008	1
O. uruma	1	0.0008	1
O. spp.	6	0.005	5
P. citri	109	8.4	18
T. cinnabarinus	78	6	25
T. floridanus	1	0.0008	1
T. kanzawai	404	31.1	53
T. piercei	26	2	11
T. truncatus	91	7	28
T. urticae	197	15.2	33
T. spp.	123	9.5	43

本調查資料中此 7 種葉蟎爲害之經濟植物種類、數量及分布各有不同，分別陳述如后。荔枝葉蟎採自臺中、南投、彰化、雲林、高雄及屛東等縣(圖1A)，採得本蟎之經濟植物包括瓠瓜、葡萄、柿子、桃、枇杷、梨、番石榴、荔枝、芋頭等，主要發現於番石榴及枇杷上，全年皆可採得，樣品(數量列於括弧中)主要來自臺中(24)、、屛東(17)、南投(11)等縣。柑桔葉蟎採自臺中、南投、彰化、雲林、高雄、屛東及臺東等縣(圖1B)，爲害植物包含天堂鳥、玫瑰、皇帝豆、柚子、檸檬、柳丁、楊桃、葡萄、番石榴、印度棗、枇杷、木瓜、桃、梨、紅豆杉、芋頭、愛玉子等，主要發現於柑橘類、楊桃、木瓜及印度棗上，全年皆可採得，樣品主要來自高雄(30)、屛東(29)、臺中(16)、南投(16)、雲林(10)等縣。赤葉蟎採自臺北、臺中、南投、彰化、雲林、臺南、高雄、屛東及花蓮等縣(圖1C)爲害植物包含滿天星、康乃馨、菊花、唐菖蒲、天堂鳥、菜豆、茄子、四季豆、絲瓜、皇帝豆、角瓜、冬瓜、葡萄、印度棗、香瓜、木瓜、桃、西瓜、花生、大豆、芋頭、苧麻、胡麻等，主要發現於花生、滿天星、芋頭、絲瓜上，全年皆可採得，樣品主要來自彰化(30)、南投(18)、臺中(9)等縣。神澤氏葉蟎採自臺北、新竹、臺中、南投、彰化、雲林、嘉義、臺南、高雄、屛東、宜蘭、花蓮及臺東等縣，除桃園縣尙未採得外，各縣均有發現(圖1D)，爲害植物有滿天星、康乃馨、菊花、唐菖蒲、天堂鳥、羊蹄甲、玫瑰、夜來香、菜豆、空心菜、胡瓜、茄子、福豆、瓠瓜、四季豆、芥菜、絲瓜、青椒、皇帝豆、角瓜、南瓜、甜椒、冬瓜、薑、香蕉、楊桃、葡萄、印度棗、枇杷、香瓜、洋香瓜、木瓜、百香果、桃、梨、西瓜、玉米、花生、大豆、甘藷、芋頭、紫蘇、胡麻、檳榔、牛蒡、檜扇等，主要發現於木瓜、茄

子、菜豆、絲瓜、葡萄、胡瓜、四季豆、花生等，全年皆可採得，樣品主要來自南投(85)、屏東(74)、彰化(63)、雲林(63)、臺中(45)、高雄(24)、臺東(19)、嘉義(17)等縣。皮氏葉蟎採自桃園、臺中、南投、彰化、高雄、屏東及臺東等縣(圖1E)，為害植物有菜豆、絲瓜、青椒、皇帝豆、薑、香蕉、葡萄、洋香瓜、西瓜、大豆、檳榔、檜扇，全年各月均有採集記錄，樣品主要來自南投縣(14)，以檳榔上採得次數最多。偽二點葉蟎採自臺中、南投、彰化、雲林、嘉義、臺南、高雄、屏東、宜蘭、花蓮及臺東等縣(圖1F)，為害菊花、唐菖蒲、天堂鳥、菜豆、芹菜、空心菜、茄子、四季豆、絲瓜、青椒、皇帝豆、南瓜、甜椒、蕃茄、葡萄、香瓜、西瓜、玉米、花生、大豆、芋頭、牛蒡、刺茄、苧麻、胡麻等，主要發現於絲瓜、花生、皇帝豆、芋頭、西瓜、菜豆、採集記錄包含全年各月份，但以6、7月較多，樣品主要來自彰化(29)、高雄(16)、嘉義(15)、屏東(9)等縣。二點葉蟎採自臺北、臺中、南投、彰化、雲林及高雄等縣(圖1G)，為害桔梗花、滿天星、康乃馨、菊花、大理花、唐菖蒲、羊蹄甲、玫瑰、不凋花、金魚草、非洲菊、菜豆、肉豆、胡瓜、茄子、福豆、四季豆、絲瓜、碗豆、青椒、辣椒、角瓜、冬瓜、木瓜、桃、梨、草莓、西瓜、花生、高粱、芋頭等，主要採自菊花、非洲菊、玫瑰、茄子、草莓、絲瓜、葡萄、各月份均有採集記錄，樣品主要來自彰化(85)、雲林(33)、南投(32)、臺中(26)、高雄(11)及臺北(10)等縣。採得二點葉蟎之地點均在臺灣西部，其在東臺灣之分布乃待多加採集後才能瞭解。另外，屏東縣先後採取了118個樣品，均未發現此蟎，可能受屏東的炎熱所抑制；確實原因猶待進一步研究探討。

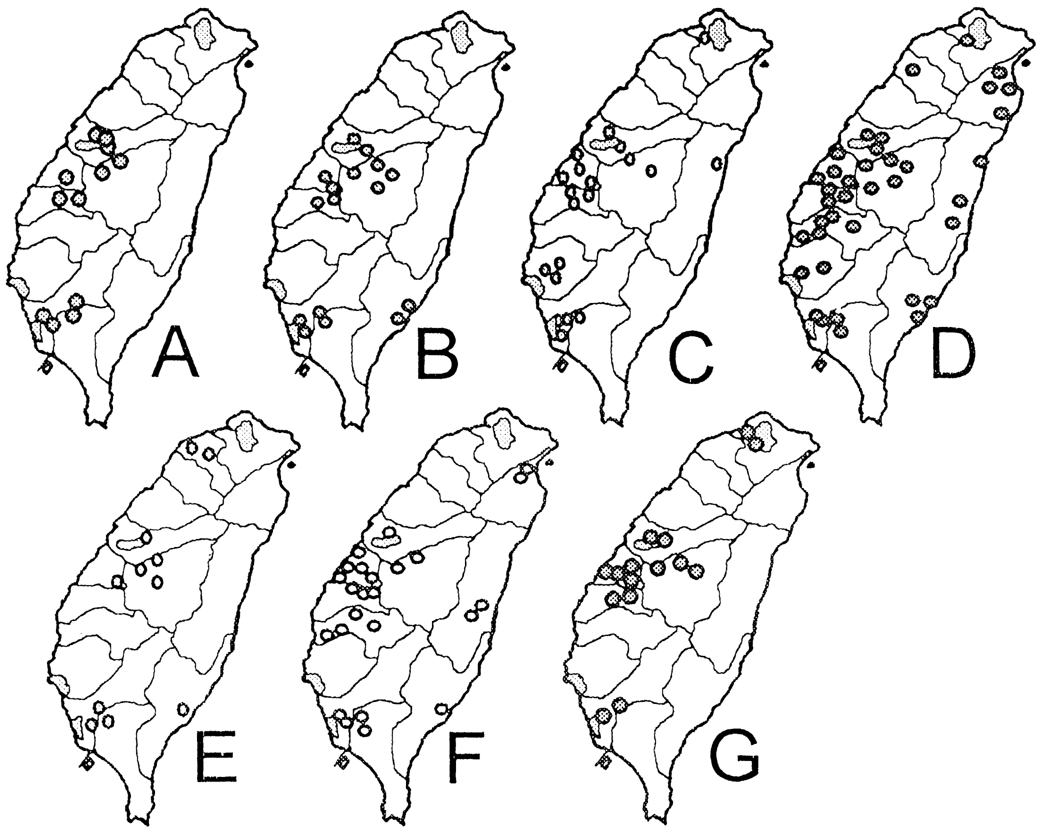

圖1. 七種葉蟎在臺灣之採集記錄：A.*Oligonychus litchii*. B. *Panonychus citri*. C. *Tetranychus cinnabarinus*. D.T. *kanzawai*. E. *T. piercei*. F. *T. truncatus*. G. *T. urticae*.

Fig. 1. Collecting records of various spider mite specus in Taiwan.

就各縣而論，臺北縣12樣品中，二點葉蟎出現10次，採自非洲菊；赤葉蟎及神澤葉蟎各 1 次，採自芋頭（表 1）。桃園縣 3 樣品均爲皮氏葉蟎，採自菜豆、洋香瓜及西瓜。新竹縣 1 樣品爲神澤氏葉蟎，採自芋頭。臺中縣169樣品中神澤氏葉蟎出現45次最多，其餘二點葉蟎26次，荔枝葉蟎24次，柑桔葉蟎16次，赤葉蟎 9次。主要採集經濟植物及其上主要發現之葉蟎（括弧內，依發現頻率排列）有楊桃（柑桔葉蟎）、胡瓜（二點葉蟎）、唐菖蒲（赤葉蟎、神澤氏葉蟎）、葡萄（神澤氏葉蟎、柑桔葉蟎、二點葉蟎）、四季豆（二點葉蟎、神澤氏葉蟎）、枇杷（荔枝葉蟎、柑桔葉蟎）、桃（二點葉蟎、神澤氏葉蟎、柑桔葉蟎、赤葉蟎）、梨（柑桔葉蟎、二點葉蟎）、毛豆（神澤氏葉蟎、赤葉蟎）、芋頭（二點葉蟎、赤葉蟎、神澤氏葉蟎）。南投縣 252 樣品中亦以神澤氏葉蟎最爲常見，出現85次，其次爲二點葉蟎32次，赤葉蟎18次，柑桔葉蟎16次，皮氏葉蟎14次，荔枝葉蟎11次，僞二點葉蟎 5 次。主要採集經濟植物及其上主要發現之葉蟎有菜豆（神澤氏葉蟎、赤葉蟎、二點葉蟎）、茄子（神澤氏葉蟎、二點葉蟎）。、葡萄（神澤氏葉蟎）、四季豆（神澤氏葉蟎、僞二點葉蟎、二點葉蟎）、絲瓜（神澤氏葉蟎）、枇杷（荔枝葉蟎）、木瓜（神澤氏葉蟎、柑桔葉蟎、二點葉蟎）、玫瑰（二點葉蟎、神澤氏葉蟎、柑桔葉蟎）、芋頭（神澤氏葉蟎、赤葉蟎、僞二點葉蟎）、非洲菊（二點葉蟎）。彰化縣 289 樣品二點葉蟎最常見，出現85次；神澤氏葉蟎次之，出現64次；赤葉蟎30次，僞二點葉蟎29次。主要採集經濟植物及其上主要發現之葉蟎有菜豆（赤葉蟎、神澤氏葉蟎、僞二點葉蟎）、菊花（二點葉蟎、僞二點葉蟎）、茄子（二點葉蟎。神澤氏葉蟎、赤葉蟎）、葡萄（神澤氏葉蟎、二點葉蟎）、木瓜（神澤氏葉蟎）、花生（赤葉蟎、神澤氏葉蟎、僞二點葉蟎）、康乃馨（赤葉蟎、二點葉蟎、神澤氏葉蟎）、玫瑰（二點葉蟎、神澤氏葉蟎、柑桔葉蟎）、芋頭（僞二點葉蟎、神澤氏葉蟎、赤葉蟎）、西瓜（神澤氏葉蟎、僞二點葉蟎）及冬瓜（神澤氏葉蟎、二點葉蟎）。雲林縣仍以神澤氏葉蟎最爲常見，152樣品中採得63次，隨之以二點葉蟎33次，柑桔葉蟎10次。主要採集經濟植物及其上主要發現之葉蟎有菜豆（神澤氏葉蟎、赤葉蟎）、菊花（二點葉蟎、神澤氏葉蟎、赤葉蟎）、唐菖蒲（神澤氏葉蟎、赤葉蟎）、絲瓜（神澤氏葉蟎、僞二點葉蟎）、木瓜（神澤氏葉蟎、柑桔葉蟎）、花生（神澤氏葉蟎、赤葉蟎、二點葉蟎、僞二點葉蟎）、草莓（二點葉蟎）。嘉義縣45樣品中採得神澤氏葉蟎、17次，僞二點葉蟎15次。主要採集經濟植物及其上主要發現之葉蟎有絲瓜（僞二點葉蟎、神澤氏葉蟎）、木瓜（神澤氏葉蟎）（1994年在嘉義之木瓜園多次觀察到二點葉蟎，未列入本資料中）、花生（僞二點葉蟎、神澤氏葉蟎）。臺南縣16樣品中神澤氏葉蟎（洋香瓜、西瓜）及赤葉蟎（胡麻）各出現 3 次，僞二點葉蟎 2 次（甘藷、胡麻）。高雄縣 109 樣品中以柑桔葉蟎最常見，採得30次；繼之以神澤氏葉蟎25次，荔枝葉蟎19次，僞二點葉蟎17次，二點葉蟎11次。主要採集經濟植物及其上主要發現之葉蟎有蕃石榴（荔枝葉蟎）、印度棗（柑桔葉蟎、赤葉蟎）、絲瓜（僞二點葉蟎、二點葉蟎、赤葉蟎神澤氏葉蟎、皮氏葉蟎）、木瓜（柑桔葉蟎、神澤氏葉蟎）。屏東縣118樣品亦以神澤氏葉蟎採得次數（74）最高，柑桔葉蟎次之(29)，僞二點葉蟎再次之(9)。主要採集經濟植物及其上主要發現之葉蟎有菜豆（神澤氏葉蟎、赤葉蟎）、楊桃（柑桔葉蟎、神澤氏葉蟎）、胡瓜（神澤氏葉蟎）、茄子（神澤氏葉蟎、僞二點葉蟎）、皇帝豆（僞二點葉蟎、神澤氏葉蟎、柑桔葉蟎、皮氏葉蟎、柑桔葉蟎）。宜蘭縣83樣品中採得神澤氏葉蟎 8 次（空心菜、茄子、四季豆、木瓜、西瓜），僞二點葉蟎 4 次（茄子、甘藷）、二點葉蟎 1 次（菊花）。花蓮縣 7 樣品中神澤氏葉蟎、僞二點葉蟎及赤葉蟎各出現了 3 次（玫瑰、菜豆、茄子）、 2 次（菜豆、刺茄）及 1 次（芋頭）。臺東縣42樣品仍以神澤氏葉蟎出現19次最高，主要發現在木瓜、甘藷及絲瓜上；木瓜上也發現柑桔葉蟎；僞二點葉蟎發現在辣椒、茄子及蕃茄上；辣椒上還發現有皮氏葉蟎。

一般而言，本調查之採樣未將山區之經濟植物（如果樹、茶樹）包含在內。因此茶葉蟎（*O. coffeae* Nietner）、歐洲葉蟎（*P. ulmi*（*koch*））、山楂葉蟎（*T. viennensis Zacher*）等雖未出現於調查結果中，但並非不具重要性。此外，所顯示出之柑桔葉蟎之重要性亦因未取樣種植在山區之

柑桔類作物而極可能偏低。

二年中先後自南投縣、彰化縣、雲林縣、高雄縣、屏東縣採取多種作物上之二點葉蟎及神澤氏葉蟎，攜回養蟲室繁殖後測試不同藥劑之推廣濃度對雌成蟎之毒性。此二葉蟎之發育期均僅約 7 天，即每月約可繁殖 4 代。爲防其對藥劑感受性在累代飼育後產生差異，致影響結果，有關測試均以在採回後 2 ～ 3 個月內進行爲原則，超過此期間即停止測試。受族群起始蟎數之影響（施藥較頻繁之經濟植物上往往蟎數甚低），也因爲部份殺蟎劑爲稍後才加入測試，因而未能對每一作物園所採回之葉蟎完成全部殺蟎劑之測試。乃選擇所做測試較爲完整之彰化縣二水鄉茄子、田尾鄉滿天星、雲林縣西螺鎮四季豆、林內鄉草莓、高雄縣大社鄉鄉絲瓜上之二點葉蟎及雲林縣林內鄉木瓜、絲瓜、二林鎮葡萄、屏東市茄子上之神澤氏葉蟎劑之感受性列爲表 3。

測試之藥劑包含有機磷劑、合成除蟲菊劑、有機氯劑、含氮化合物、有機硫磺劑、有機溴劑、有機錫劑及混合劑，以含氮化合物類具有較佳之毒效，其餘則多僅對神澤氏葉蟎較有效。因測試之目的僅爲尋找有效之殺蟎劑，及了解是否在各地有所不同，並非做毒理方面之探討；所測試之藥劑數不多，而且同類藥劑之表現並不完全一致，*formetanate* 對屏東市茄子之神澤氏葉蟎之毒效即不強，在一些其它測試中亦有效果不理想（因所測藥劑數過少而未列入表 3）時；是以不討論抗藥性之產生與輕重，及哪一類型藥劑較具防治效果。

受測藥劑中，多數對二點葉蟎均效果不佳，僅50% *formetanate S. P.*及30% *dinobuton E.C.* 穩定地表現出優良之殺蟎效果。另外68.1% *propargite E.C.* 對高雄大社絲瓜上採回之二點葉蟎亦有良好之毒效。神澤氏葉蟎之有效防治藥劑則較多，除上數 3 種殺蟎劑外，2.8% *cyhalothrin E.C.* 對雲林縣林內鄉絲瓜及木瓜上神澤氏葉蟎有效，但對採自同鄉葡萄上之神澤氏葉蟎無效。20% *amitraz E.C.* 亦對雲林縣林內鄉絲瓜及木瓜上神澤氏葉蟎有效。25% *bromopropylate E.C.* 除對雲林縣林內鄉葡萄上之神澤氏葉蟎效果不好外，對其餘被測之神澤氏葉蟎均有良好之毒殺效果。35% *Venthene W.P.* 對受測之神澤氏葉蟎均造成100%之死亡率。就採自雲林縣林內鄉草莓之二點葉蟎而言，受測之殺蟎劑全都已無防治效果，爲表 3 中 *dinobuton* 唯一未造成高死亡率者。

農民施藥時常提高劑量使用，是以亦測試推廣濃度四倍劑量下葉蟎之死亡率，結果列於表 4 。在此劑量下，除了草莓外，*propragite* 及 *bromoprophylate* 對各受測作物上之葉蟎均有高致死率。*Venthene* 則對高雄大社絲瓜、雲林林內草莓及彰化田尾滿天星上二點葉蟎毒效不理想外，其餘均表現良好。此外，提高劑量後*cyhalothrin* 對受測之神澤氏葉蟎都有高致死力，而 *omethoate* 及 *ethion* 也分別對雲林林內之神澤氏葉蟎表現出不同之致死效果。

綜合而言，表 3、4 顯示目前可施用 *propargite*、*bromopropylate*及 *Venthene* 防治多種農作物上之二點葉蟎及神澤氏葉蟎，施用 *cyhalothrin* 防治神澤氏葉蟎並施用 *omethoate* 及 *ethion* 在部份地區防治神澤氏葉蟎。*Formetanate*、*dinobuton* 及 *amitraz* 均屬含氮化合物，後二者因致畸型胎或致腫瘤已被限制其使用，但爲瞭解是否此類殺蟎劑均有良好效果，乃亦予選測。雖均表現出高殺葉蟎能力，不可隨意選用。而前者在人體難代謝，選用時應謹愼。各藥劑防治不同地區葉蟎之效果亦可能有小差異，表 3 中 *formetanate* 對各地葉蟎雖均具100%之毒殺率，但對屏東市茄子上葉蟎僅具62%之致死率。雖然提高劑量後仍造成97.3%之死亡率，但已意味葉蟎對該藥劑之感受性有降低之情形。而提高劑量施用實爲不當之行爲，且就對農業感受性之降低而言，當推廣濃度無效時，提高劑量雖能達成防治目的，必將不能持久，短期內此提高之劑量將再喪失防治效果。是以上述測試篩選出之殺蟎劑將有可能在短期內對葉蟎失去防治效力，使得葉蟎之防治再度面臨困局。在有效防治藥劑日減、新藥開發緩慢、對農藥殘毒之考量日益受重視之情形下，很難有周全之解決方法。較可行也必須進行之道爲改善施藥策略，將施藥間隔拉長，或依葉蟎實際發生密度而施藥，以降低施藥頻率，求取對農民損失較低但能減輕殘毒顧慮之方法。

表 3. 12種殺蟎劑之推廣濃度於室內測試中對採自7種作物之神澤氏葉蟎及二點葉蟎之毒效

Table 3. Laboratory toxicity (mortality %) of the recommended concentration of 12 acaricides to T. *Kanzawai* (TK) and T. *urticae* (TU) collected from 7 crops.

Chemicals	rate	Star sky	Kidney bean	Eggplant		Sponge gauge		Papaya	Grape	Strawberry
	rate	(TU)[z]	(TU)[y]	(TU)[x]	(TK)[w]	(TU)[u]	(TK)[v]	(TK)[v]	(TK)[t]	(TU)[v]
50 % omethoate S.	1500x	…	2.5	…	…	…	20.0	35.0	74.1	16.7
46.5% ethion E.C.	800x	15.7	…	13.5	17.8	32.9	…	49.2	10.9	…
2.8% cyhalothrin E.C.	1000x	…	35.7	1.1	10.9	23.9	89.2	88.0	37.2	5.0
20% benzomate E.C.	1500x	…	1.9	10.9	11.4	…	…	10.1	…	…
50% formetanate S.P.	1000x	85.7	100.0	100.0	62.0	100.0	100.0	…	…	…
30% dinobuton E.C.	1200x	100.0	93.7	97.3	…	97.3	100.0	100.0	100.0	30.0
20% amitraz E.C.	800x	…	…	…	…	…	96.7	100.0	…	8.2
68.1% propargite E.C.	1600x	…	64.3	42.4	100.0	95.3	…	100.0	100.0	26.2
35% fenothiocarb E.C.	1500x	37.5	1.9	…	…	…	56.7	5.9	…	3.3
25% bromopropylate E.C.	500x	70.1	25.0	5.9	100.0	6.5	99.1	100.0	52.0	30.0
50% fenbutatin-oxide W.P.	1500x	…	13.3	23.1	48.8	11.9	23.3	…	…	9.2
35% Venthene W.P.	500x	30.0	69.0	63.7	100.0	44.7	…	100.0	100.0	13.2

[z] Tienwei, Chunghua County
[y] Hsilou, Yunlin County
[x] Ersuei, Chunghua County
[w] Pintung, Pintung County
[v] Linnei, Yunlin County
[u] Dasir, Kaohsiung County
[t] Erlin, Yunlin County

表 4. 12種殺蟎劑之推廣濃度之四倍劑量於室內測試中對採自7種作物之神澤氏葉蟎及二點葉蟎之毒效

Table 4. Laboratory toxicity (mortality %) of 12 acaricides to T. *kanzawai* (TK) and T. *urticae* (TU) collected from 7 crops at the dose of 4 times of the recommended comcentration.

Chemicals	rate	Star sky	Kidney bean	Eggplant		Sponge gauge		Papaya	Grape	Strawberry
	rate	(TU)[z]	(TU)[y]	(TU)[x]	(TK)[w]	(TU)[u]	(TK)[v]	(TK)[v]	(TK)[t]	(TU)[v]
50% omethoate S.	375x	…	25.8	…	…	…	20.0	91.9	100.0	40.8
46.5% ethion E.C.	200x	29.8	…	46.0	73.1	91.7	…	92.9	17.5	…
2.8% cyhalothrin E.C.	250x	…	72.8	4.0	85.3	40.5	97.5	92.9	100.0	7.5
20% benzomate E.C.	750x	…	3.5	13.3	71.1	…	…	71.2	…	…
50% formetanate S.P.	250x	100.0	100.0	100.0	97.3	100.0	100.0	…	…	…
30% dinobuton E.C.	300x	100.0	98.3	100.0	…	100.0	100.0	100.0	100.0	96.7
20% amitraz E.C.	200x	…	…	…	…	…	97.5	100.0	…	23.6
68.1% propargite E.C.	400x	…	94.2	86.5	100.0	100.0	…	100.0	100.0	63.3
35% fenothiocarb E.C.	750x	41.7	16.7	…	…	…	82.5	42.4	…	25.8
25% bromopropylate E.C.	125x	95.0	89.2	78.3	100.0	83.5	100.0	100.0	100.0	42.0
50% fenbutatin-oxide W.P.	750x	…	31.7	52.4	80.1	36.2	41.7	…	…	22.5
35% Venthene W.P.	125x	73.0	97.3	97.2	100.0	41.6	…	100.0	100.0	67.5

Refer to Table 3 for foot notes.

誌　謝

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Spider Mites Injurious to Economic Plants in Taiwan and the Toxicity of Twelve Acaricides to Two Major Species (Tetranychidae;Acari)[1]

Chyi-Chen Ho, Kang-Chen Lo and Wen-Hua Chen[2]

Summary

The survey on the spider mites infesting economic plant in Taiwan during 1991-1993 recorded nine species, with seven species appeared frequently. ***Tetranychus kanzawai*** Kishida was most commonly found, and infested more hosts than the others, followed by *T. urticae* Koch. *T. truncatus* Ehara was comparable to *T. cinnabarinus* (Boisduval) in the frequency of occurrence, the number of host plant, and the range of geographical distribution. Its importance was obviously under-estimated in the past. The collecting frequency of *Panonychus citri* (McGregor) was biased as mountain area was generally not surveyed. *Oligonychus litchii* Lo et Ho, and *T. piercei* McGregor were less frequently collected than the above species. The toxicity of the recommended concentration of 12 acaricides to *T. kanzawai* and *T. urticae* collected on 7 crops from 9 fields were tested in laboratory. 50% formatante S. P. and 30% dinobuton E. C. showed high toxicity to both mite species. 68.1 % propargite E. C. was toxic to *T. urticae* in some areas and was toxic to *T. kanzawai* collected from all investigated fields. 2.8% cyhalothrin E. C., 20% amitraz E. C., 25% bromopropylate E. C. and 35% Venthene W. P. were toxic to *T. kanzawai.*

Key words : Economic plant, Spider mite, Toxicity.

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麥蛾對巴賽松之抗藥性研究[1]

姚 美 吉　　羅 幹 成[2]

摘要：長期使用巴賽松 (phoxim) 防治積穀害蟲後，本省最重要之鱗翅目積穀害蟲麥蛾 (*Sitotroga cerealella Olivier*) 部分品系已對巴賽松產生明顯抗藥性。以巴賽松對麥蛾之半數擊倒濃度 (KC_{50}) 進行比較，其中民雄品系抗藥性最強，和美品系最敏感，對巴賽松之相對抗藥性比最高達36。民雄抗藥性品系對有機磷藥劑陶斯松及氨基甲酸鹽之免敵克具較明顯交互抗性，而對除蟲菊類則無交互抗藥性現象發生。溫度對藥劑之毒效影響極明顯，有機磷及氨基甲酸鹽類藥劑之毒效隨溫度成比例增加，但除蟲菊類則呈負相關，20°C時第滅寧對民雄之巴賽松高抗性品系的毒效最好。30°C則以賽滅寧最佳，免敵克毒效亦尚佳。因此建議冬季使用除蟲菊類藥劑，夏季則與免敵克輪替使用。

關鍵詞：麥蛾、巴賽松、交互抗性、溫度。

麥蛾 (*Sitotroga cerealella* Olivier) 爲本省重要之鱗翅目倉庫害蟲，成蟲喜產卵於麻布袋之縫隙間或稻穀表面。一齡幼蟲因蟲體甚小，可自由進入細麻袋內，侵入稻穀中生長發育。幼蟲蛀食穀粒，使穀粒空心，5至9月時爲害嚴重[3,8]。爲害對象以稻穀爲主，於糙米倉則甚少爲害，且稻穀倉又以散裝倉較袋裝倉嚴重。爲害地區的分佈上，花東區高於西部各區[2,6]。

本省對麥蛾之防治以藥劑爲主，1971年改用馬拉松 (malathion)，1979年以後則以巴賽松 (phoxim) 使用至今。高和曾[5]調查不同品系之麥蛾對馬拉松及巴賽松之抗藥性程度，發現對馬拉松之相對抗藥性比 (relative resistance ratio) 最高達111，對巴賽松亦達81。此結果顯示麥蛾對馬拉松及巴賽松均已產生抗藥性，但對其他種類殺蟲劑是否產生交互抗性，均值得儘速瞭解。

爲瞭解長期使用巴賽松後，麥蛾對其他藥劑是否產生交互抗性和解決倉庫之麥蛾防治問題，本試驗自1994年5月起分別至全省之穀倉採集各地麥蛾品系，進行對巴賽松抗藥性程度測試，並從其中選出對巴賽松之感性及抗性品系。選擇三類八種倉庫害蟲常用防治藥劑[12]，包括有機磷類之陶斯松 (chlorpyrifos) 及馬拉松 (malathion)，氨基甲酸鹽類之免敵克 (bendiocarb) 及加保利 (carbaryl)，與除蟲菊類之百滅寧 (permethrin)、第滅寧 (deltamethrin) 及賽滅寧 (cypermethrin)，並比較此兩品系對三類殺蟲劑之交互抗性情形，篩選有效藥劑，提供未來防治上交替應用。本實驗室在穀蠹的防治研究上發現溫度對藥劑之毒效影響極大[4]，因此本試驗亦進一步探討溫度對藥效之影響，並了解麥蛾對巴賽松之抗藥機制，以確實解決抗藥性問題。

材料與方法

一、供試藥劑

三類八種殺蟲劑及三種協力劑，分別爲

1. 臺灣省農業試驗所　研究報告第 1788 號。
2. 本所應用動物系助理及研究員兼系主任。臺灣省　臺中縣　霧峰鄉。

(一)巴賽松（phoxim），82.7%工業級原體，興農公司提供。
(二)陶斯松（chlorpyrifos），95%工業級原體，惠光公司提供。
(三)馬拉松（malathion），95%工業級原體，興農公司提供。
(四)加保利（carbaryl），99%工業級原體，興農公司提供。
(五)免敵克（bendiocarb），50%可濕性粉劑，發順公司提供。
(六)百滅寧（permethrin），90%工業級原體，興農公司提供。
(七)第滅寧（deltamethrin），98%工業級原體，興農公司提供。
(八)賽滅寧（cypermethrin），90%工業級原體，興農公司提供。
(九)氧化酵素（microsomal monooxygenases）抑制劑 piperonyl butoxide （PB），90%分析試劑購自 Aldrich Chemical（Milwaukee, Wis.）。
(十)水解酵素（esterases）抑制劑 *S,S,S*-tributyl phosphorotrithioate（TBPT），70.5%工業級原體由 Chemagro Co.製造。
(士)麩胱甘肽轉基酶（glutathione-*S*-transferases）抑制劑 N-ethylmaleimide（NEM），100%分析試劑購自 Sigma 公司（St Louis, MO）。

二、供試蟲源

麥蛾自1994年５月起採自全省各地穀倉，包括湖口（Hukou）、觀音（Kuanyin）、後龍（Houlung）、霧峰（Wufeng）、和美（Homei）、溪州（Chichou）、南埔（Nanpu）、民雄（Minhsiung）、元長（Yuanchang）、後壁（Houpi）。屛東（Pintung）、臺東（Taitung）等十二處。同一地區採集2～3個穀倉之麥蛾加以混合，攜回室內繁殖，以第三子代以後成蟲供作試驗。

三、藥劑處理

本試驗測試方法乃參照聯合國糧農組織（FAO）於1979年所推薦「農業害蟲對農藥抗藥性的偵測法」中之「倉儲鱗翅目害蟲成蟲抗藥性之測定方法一乾膜法」[22]進行測試。

將配成之4～6個處理濃度之１ml 丙酮藥液倒入250ml 之三角錐瓶（高10公分、口徑2.5公分）均勻滾塗瓶壁，作成殘留藥膜瓶，對照組則以丙酮溶液取代藥液，每處理濃度３重覆。30°C下每一殘留藥膜瓶分別置入15隻於24小時內羽化之麥蛾成蟲，並使藥瓶平躺，經６小時後觀察擊倒率（Knockdown），判斷的標準爲翻轉三角瓶，視麥蛾成蟲倒下無法再站起，所得之數據再以Finney[10]對機數分析法求得半擊倒濃度（KC_{50}）及相關資料。

四、溫度對藥效之影響及交互抗性的評估

在20°C及30°C下，分別比較巴賽松感性及抗性之麥蛾品系對有機磷劑、氨基甲酸鹽及除蟲菊類等八種殺蟲劑之感受性，以了解交互抗性程度，並評估藥劑受溫度影響之趨勢，供不同季節用藥之參考。

五、麥蛾對巴賽松抗藥機制之探討

先測試氧化酵素抑制劑 PB、水解酵素抑制劑 TBPT 及麩胱甘肽轉基酶抑制劑 NEM 對麥蛾之最高不致死濃度，在30°C下，再以該濃度 1 ml 藥液混合巴賽松藥液，其餘處理方法同上，求得 KC_{50}，再計算協力效果，以推測抗藥性發生的原因。

結果與討論

一、各地區麥蛾品系對巴賽松之感受性

利用乾膜法測得不同採集區麥蛾對巴賽松之感受性如表１。各品系中以和美品系對巴賽松最敏感，KC_{50}爲8.1ppm，民雄品系抗藥性最高，KC_{50}爲292ppm。若以不同採集區之麥蛾對巴賽松所測得之 KC_{50} 值與和美品系對巴賽松 KC_{50} 值相比較，所得之相對抗性倍數比（Relative resistance

ratio for KC_{50}）以下簡稱 RR，其中以民雄品系最高，可達36倍，其他品系亦介於1.5～18倍之間。

表 1. 30°C時不同採集區麥蛾對巴賽松之感受性

Table 1. Toxicity of phoxim against adults of *Sitotroga cerealella* collected from different areas of Taiwan at 30°C[z]

Strains	KC_{50} (95%FL) (ppm)	Slope±SE	RR[y]
Homei	8.1 (4.45～17.2)	1.29±0.20	1.0
Chichou	12.5 (6.46～28.3)	1.22±0.20	1.5
Houlung	40.3 (23.1～61.6)	1.84±0.47	5.0
Houpi	148.3 (74.4～592)	0.96±0.27	18.3
Hukou	42.6 (24.2～95.4)	1.23±0.32	5.3
Kuanyin	77.2 (54.3～110)	1.84±0.32	9.6
Minhsiung	291.8 (182～904)	1.64±0.42	36.0
Nanpu	96.2 (52.5～2422)	1.84±0.70	11.9
Pintung	42.9 (20.4～66.7)	2.08±0.64	5.3
Taitung	77.4 (33.9～157)	1.24±0.33	9.6
Wufeng	18.9 (9.21～37.6)	1.43±0.40	2.3
Yuanchang	15.1 (8.77～24.4)	1.29±0.21	1.9

[z] 15 adults/replicate, 3 replicates/trial, 4 trials/strain.
[y] RR (Relative Resistance ratio) , KC_{50} of the test strains divided by the KC_{50} of Homei strain

高和曾[5]以同一方法處理各地區品系之麥蛾成蟲對巴賽松之感受性，結果南埔品系之 KC_{50} 最高，爲69.1ppm。臺東品系最敏感，爲0.85ppm。此次調查結果，各地區麥蛾對巴賽松之抗藥性已逐漸提升。顯示近年來巴賽松對麥蛾已漸失防治效果，未來麥蛾之防治應儘速篩選出取代藥劑，以避免麥蛾對巴賽松抗藥性之持續發展。

麥蛾抗藥性之發展分布，由 RR 值較高地區如民雄、觀音、南埔、後壁、臺東等，均呈點狀分布，似無偏重何地方。且本省穀蠹對巴賽松及玉米象對馬拉松之抗藥性分布，亦有相似現象[1,4]。從調查結果顯示穀蠹對巴賽松抗性較高的倉庫，其麥蛾對巴賽松亦呈現較高抗性，因此推測麥蛾對巴賽松之抗藥性發展與穀蠹相似，主要與地區之藥劑長期使用、使用頻率及倉庫形態有密切關係[4]。

二、交互抗性的評估及溫度對藥效之影響

在交互抗性的評估上，在30°C時三類八種藥劑對和美敏感品系及民雄抗性品系毒效比較如表 2。對和美品系之毒效，以巴賽松毒效最佳，KC_{50}爲8.1ppm。其中除蟲菊類藥劑較有機磷及氨基甲酸鹽類有效，但有機磷之巴賽松及氨基甲酸鹽的免敵克之毒效與除蟲菊類相當；八種藥劑對民雄品系麥蛾的毒效則變化較大，其中以賽滅寧毒效最佳，KC_{50} 爲13ppm，其餘以除蟲菊類藥劑毒效較佳，再其次爲免敵克。

表 2. 30°C時，和美及民雄品系麥蛾對不同藥劑之交互抗性

Table 2. Cross resistance of Homei and Minhsiung strains of *S. cerealella* to eight insecticides at 30°C.

Insecticides	KC_{50} (95%FL) (ppm)		RR[z]
	Homei strain	Minhsiung strain	
Chlorpyrifos	191 (112~280)	1717 (1271~2876)	9
Malathion	134 (58~202)	802 (613~1322)	6
Phoxim	8 (4.4~17.2)	292 (182~904)	36
Bendiocarb	14 (10.1~17.1)	99 (62~320)	7.4
Carbaryl	3685 (1894~19586)	〉10000	〉2.7
Cypermethrin	14 (10.2~18.8)	13 (7.8~20.1)	0.9
Deltamethrin	9 (4.8~19.5)	21 (12.4~33)	2.3
Permethrin	29 (20~38)	14 (6.8~22.8)	0.5

[z] RR, KC_{50} of Minhsiung strain divided by the KC_{50} of Homei strain.

在20°C時各藥劑對兩品系之毒效如表3。各藥劑對和美品系之毒效，以第滅寧藥效最佳，KC_{50}為5ppm。其次為免敵克；八種藥劑對民雄品系麥蛾的毒效差異更大，其中仍以第滅寧毒效最佳，KC_{50}為10ppm，其餘藥劑亦以除蟲菊類藥劑較有機磷及氨基甲酸鹽類有效。

表 3. 在20°C時，和美及民雄品系麥蛾對不同藥劑之交互抗性

Table 3. Cross resistance of Homei and Minhsiung strains of *S. cerealella* to eight insecticides at 20°C.

Insecticides	KC_{50} (95%FL) (ppm)		RR[z]
	Homei strain	Minhsiung strain	
Chlorpyrifos	517 (299~823)	2953 (1959~8150)	5.7
Phoxim	213 (128~310)	1924 (1347~2501)	9
Malathion	384 (200~916)	839 (633~1138)	2.2
Bendiocarb	16 (12.6~18.9)	64 (44~124)	4
Carbaryl	〉10000	〉10000	…
Cypermethrin	17 (13.1~21.8)	15 (4.6~27.2)	0.9
Deltamethrin	5 (2.2~10.1)	10 (5.9~14)	2
Permethrin	25 (16~34)	21 (15~33)	0.8

[z] RR, KC_{50} of Minhsiung strain divided by the KC_{50} of Homei strain.

比較兩品系在30°C及20°C下對八種藥劑的抗性倍數比（RR值），發現對巴賽松高度抗性之民雄品系，對另外兩種有機磷劑陶斯松、馬拉松亦產生抗性。此現象與穀蠹極為相似，其交互抗性的產生除可能受巴賽松抗性之影響外，亦可能來自早期馬拉松之廣泛使用及近幾年在倉庫中亦有使用陶斯松燻煙劑等所產生之抗性。但穀蠹對氨基甲酸鹽類並無產生交互抗性，而麥蛾對氨基甲酸鹽類之免敵克

、加保利卻呈現交互抗性現象，其中免敵克毒效尚可，而加保利的毒效在兩種溫度下均不理想。對除蟲菊類之百滅寧、第滅寧、賽滅寧則無交互抗性，且三種除蟲菊藥劑對麥蛾之毒效均佳。

謝等[8]比較六種殺蟲劑與稻穀混拌處理一年期間對麥蛾之防治效果，其中以百滅寧及第滅寧的效果最好，且在低溫時其藥效並未降低，反有上升趨勢。本次測試亦有相同結果，除蟲菊類毒效均佳，而氨基甲酸鹽類免敵克毒效亦尚可，且藥劑對穀蠹之毒效亦以此兩類藥劑爲佳[4]。因積穀中主要害蟲爲穀蠹及麥蛾，未來積穀害蟲防治上可參照上述研究成果作綜合考量，在冬季主要使用除蟲菊類藥劑，於夏季則改以和免敵克交替防治使用，將可延緩害蟲抗藥性之發生。

溫度變化對藥劑之毒效有相當程度影響，如大部分有機氯及除蟲菊類殺蟲劑之毒效受溫度之影響呈現顯著之負效應[19]。氨基甲酸鹽類殺蟲劑略呈負效應，而有機磷劑則具正效應[11,13,14,15]。溫度變化對有機磷藥劑在麥蛾上之毒效有顯著影響，巴賽松、陶斯松及馬拉松對和美品系及民雄品系之麥蛾毒效，均隨溫度增加，KC_{50}值變小，毒效增強。此結果與謝等[7]、Iordanou and Watters[14]、O'Donnell[17]及 Wilkin and Haward[21]等人之試驗結果相吻合。且其中巴賽松的毒效影響最大，和美品系相差達26倍，民雄品系亦達6.6倍。而第滅寧呈負效應，在低溫下對兩品系毒效均有小幅提升，但氨基甲酸鹽類之免敵克及加保利亦則正效應，與除蟲菊類及氨基甲酸鹽類受溫度影響呈負效應之研究結果有極大差異[20,21]，其原因值得進一步研究。

三、麥蛾對巴賽松抗藥性機制之探討

測試氧化酵素抑制劑 PB、水解酵素抑制劑 TBPT 及麩胱甘肽轉基酶抑制劑 NEM 對麥蛾之最高不致死濃度分別爲50ppm、250ppm 和50ppm。添加協力劑於巴賽松後對二種品系麥蛾毒性所造成的協效果（synergism）如表 4，協力劑 PB（SR＝0.97）和 NEM（SR＝1.04）對巴賽松均無協力效果，而 TBPT（SR＝5.1）則呈現協力效果；在民雄抗性品系上，協力劑 PB（SR＝1.2）和 NEM（SR＝1.1）對巴賽松亦無協力效果，而添加 TBPT 毒效增強，協力效果達3.4倍。

表 4. 30°C下協力劑對巴賽松處理和美及民雄品系麥蛾之毒效影響

Table 4. Effect of synergists on phoxim toxicity to Homei and Minhsiung strains of *S. cerealella* at 30°C.

Treatment	KC_{50} (95%FL) (ppm)	Slope±SE	SR^z
Homei strain			
Phoxim	8.1 (4.4～17.2)	1.29±0.20	
$+PB^y$	8.3 (0.7～18.5)	1.18±0.38	1.0
$+TBPT^x$	1.6 (0.4～4.6)	0.71±0.20	5.1
$+NEM^w$	7.8 (3.9～18.5)	0.97±0.22	1.0
Minhsiung strain			
Phoxim	292 (182～904)	1.64±0.42	
+PB	250 (182～365)	1.57±0.29	1.2
+TBPT	87 (33～241)	0.78±0.21	3.4
+NEM	268 (187～408)	2.15±0.57	1.1

z SR (Synergistic ratio), KC_{50} without synergist divided by the KC_{50} with synergist.
y PB, piperonyl butoxide.
x TBPT, *S,S,S*-tributyl phosphorotrithioate.
w NEM, N-ethylmaleimide

麥蛾對巴賽松的抗藥性機制若是因解毒酵素的分解所產生，則添加協力劑於殺蟲劑中可以測得協力效果，就能推測出抗藥性發生的可能原因[9,16]。和美品系添加氧化酵素抑制劑 PB 及麩胱甘肽轉基酶抑制劑 NEM 對巴賽松毒效並無影響，而水解酵素抑制劑 TBPT 則呈現5.1倍的協力效果，顯示和美品系體內水解酵素參與巴賽松的代謝。而對民雄高抗品系，三種協力劑對巴賽松協作用與和美品系相似，僅有水解酵素抑制劑 TBPT 呈現較明顯協力作用。由上述結果推測水解酵素在兩品系之作用與麥蛾對巴賽松的抗藥性有密切關係。

藉由添加酵素抑制劑來探討麥蛾對巴賽松抗藥性，因 TBPT 協力效果約3～5倍，而抗藥倍數可達36倍，因此抗藥機制除水解酵素之影響外，應還有其它機制。因此未來若能朝其蟲體內各解毒酵素的量及質的變化，或另兩項主要抗藥機制如神經作用部位不敏感及藥劑穿透表皮速率的降低上進行探討[18]，將可更明確瞭解。

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Phoxim Resistance in *Sitotroga Cerealella* Olivier in Taiwan[1]

Me-Chi Yao and Kang-Chen Lo[2]

Summary

Sitotroga cerealella Olivier, one of the most important lepidopteran insect pests of stored grains in Taiwan, has developed resistant to phoxim after continuous chemical applicatioons for 15 years. Survey results revealed that Minhsiung strain was the most resistant while Homei strain was the most susceptible to phoxim with a resistance ratio found in Minhsiung strain of 36. Minhsiung strain showed cross resistance to chlorpyrifos and bendiocarb but not to pyrethroids. Temperature is a major factor that significantly influences the performance of insecticides. Organophosphorus and carbamate insecticides were more toxic to this insect at 30°C than at 20°C. On the other hand, pyrethroids showed negative temperature coefficient. Deltamethrin was more effective at 20°C in Minhsiung strain, and cypermethrin was more toxic at 30°C. Effectiveness of insecticides against stored-product insects may vary with seasons. Pyrethroids are suggested to be applied to control stored-product insects in the winter season, and bendiocarb in the summer.

Key words : *Sitotroga cerealella,* Phoxim, Cross resistance, Temperature.

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The Braconidae (Hymenoptera) of Taiwan

V. Cardiochilinae and Orgilinae[1]

Liang-Yih Chou[2]

Abstract : Five species of Cardiochilinae and 18 species of Orgilinae from Taiwan are recognized in this paper. Among them, 14 species are new to science and 2 species are new to the fauna of Taiwan. Keys to the Taiwanese genera and species of the subfamilies Cardiochilinae and Orgilinae are also presented.

Key words : Cardiochilinae, Orgilinae, Braconidae, Taxonomy, Taiwan.

INTRODUCTION

The subfamily Cardiochilinae contains about 165 species in the world, including 5 species in Taiwan. They are endoparasitoids of larvae of Pyralidae, Noctuidae, Cosmopterigidae, Gelechiidae, Tortricidae and Epiplemidae[(11)]

The subfamily Orgilinae contains about 275 species worldwide, including 3 species in Taiwan. They are endoparasitoids of larvae of Pyralidae, Tortricidae, Coleophoridae, Gelechiidae, Oecophoridae and Gracillariidae[(1)]. Eighteen species of this subfamily from Taiwan are recognized in this paper, of which 14 species are new to science.

Van Achterberg[(4)] provided key to distinguish the subfamilies Cardiochilinae and Orgilinae from the other Braconidae. The terminology used here mainly follow Huber and Sharkey[(12)], Wahl and Sharkey[(16)] and van Achterberg[(2)]. Others are defined here. The letter OD is the greatest diameter of a posterior ocellus. The tentorial index is tentorio-ocular line over intertentorial line. The specimens used in this study are deposited in the Insect Collection of the Taiwan Agricultural Research Institute, Taichung, Taiwan, R.O.C.

The following abbreviations of collectors are used in the specimens examined: CCC (C. C. Chen), CCCh (C.C. Chien), CCP (C.C. Pan), CHW (C.H. Wang), CHY(C.H. Yang), CJL (C.J. Lee), CNL (C.N. Lin), JS (J. Sonan), KCC (K.C. Chou), KSL(K.S. Lin), LYC (L.Y. Chou), SCL (S.C. Lin), SPH (S.P. Huang), TL (T. Lin), WST (W.S. Tang).

The county and altitudes of the localities which occur in the text are as follows: CHIAYI: Chiayi, Chuchi, Meishan.

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HSINCHU: Wufeng 400m.
HUALIEN: Fuli, Tayuling 2560m.
ILAN: Shuiyuan.
KAOHSIUNG: Chiasien, Chihshan, Liukuei, Maolin.
NANTOU: Lienhuachih 650m, Lushan 1000m, Meifeng 2150m, Sungkang 2100m, Sunmoonlake, Tsuifeng 2300m, Tungpu 1200m, Wushe 1150m.
PINGTUNG: Chaochou, Kenting, Ouluanpi, Shantimen.
TAICHUNG: Wanfeng, Wuling 1900m.
TAINAN: Tainan.
TAIPEI: Chutzuhu, Taipei.
TAITUNG: Chengkung, Chihpen, Tawu, Tungho.
TAOYUAN: Fuhsing.
YUNLIN: Hsilo.

Subfamily CARDIOCHILINAE

The Cardiochilinae are characterized by the following combination of characters: occipital carina absent, vein 4/Rs of fore wing weakly sclerotized and decurved, cell 1+2Rs of fore wing present and distinctly wider than long; and first metasomal tergum with spiracle on laterotergite. This subfamily consist of 6 genera(10,14). Two genera, *Cardiochiles* Nees and *Hartemita* Cameron, have been known to occur in Taiwan.

Key to genera of Cardiochilinae from Taiwan

1. Eye setose; hind basitarsus tubular; ovipositor sheath distinctly longer than half length of hind basitarsus ········· *Cardiochiles* Nees
2. Eye bare; hind basitarsus flattened or laminate; ovipositor sheath shorter than half length of hind basitarsus ········· *Hartemita* Cameron

Genus *Cardiochiles* Nees

Cardiochiles Nees, 1818. Nova Acta Acad. nat. Curios. 9:307, no species. Type pecies: *Ichneumon saltator* Fabricius, first included species, Nees, 1834. - Nees, 1834. Hym. Ichn. affin. Mon. 1:224. - Sharkey & Mason, 1986. Proc. Entomol. Soc. Wash. 88(2):301.

Helcon (*Cardiochiles*): Haliday, 1835. Ent. Mag. 3:145.

Toxoneuron Say, 1836. Boston J. nat. Hist. 1:258. Type species: *Bracon* (*Toxoneuron*) *viator* Say, by subsequent designation, designated by Viereck, 1914. - Viereck, 1914. Bull. U.S. natn. Mus. 83:146.

Tenthredoides Cresson, 1865. Proc. ent. Soc. Philad. 4:290. Type species: *Tenthredoides seminiger* Cresson, by monotypy.

Ditherus Cameron, 1902. J. Bombay nat. Hist. Soc. 14:434. Type species: *Ditherus ruficollis* Camaron, by monotypy.

Schonlandella Cameron, 1904. Rec. Albany Mus. 1:169. Type species: *Schonlandella nigromaculata* Cameron, by subsequent designation, designated by Viereck, 1914. -

Viereck, 1914. Bull. U.S. natn. Mus. 83:132.

Ernestiella Cameron, 1905. Spolia zeylan. 3:81. Type species: *Ernestiella nigromaculata* Cameron, by monotypy.

Psilommiscus Enderlein, 1912. Arch. Naturgesch. 78A:98. Type species: *Psilommiscus sumatranus* Enderlein, by monotypy.

Asiacardiochiles Telenga, 1955. Fauna SSSR 5(4):236. Type species: *Asiacardiochiles mimutus* Telenga.

The genus *Cardiochiles* is characterized by the following combination of characters: eye setose; cell 1M of fore wing elongate; hind basitarsus tubular or at most slightly flattened; hypopygium usually pointed posteriorly; ovipositor and ovipositor sheath usually reaching well beyond apex of metasoma, straight or evenly curved throughout their length. It contains about 150 species in the world, including 3 species in Taiwan[18].

Key to species of the genus *Cardiochiles* from Taiwan

1. Head and notauli smooth ······································· 2
-. Head partly rugose, notauli crenulate ······························· *albopilosus* Szépligeti
2. Body reddish yellow; stigma brown to dark brown, lighter basally ············ *szepligeti* Enderlein
-. Body black; stigma dark brown entirely ······························· *laevifossa* Enderlein

Cardiochiles albopilosus Szépligeti

Cardiochiles albopilosus Szépligeti, 1902. Természetr. Füz. 25:78. - Watanabe, 1934. Insecta matsum. 8(4):204. - Watanabe, 1937. J. Fac. Agric. Hokkaido (imp.) Univ. 42(1):144.

Specimen examined: Specimen was not available to study.

Distribution: Singapore, Sumatra and Taiwan.

Host: Unknown.

Cardiochiles laevifossa Enderlein
(Fig. 1)

Cardiochiles laevifossa Enderlein, 1906. Stettin. ent. Ztg. 67:248. - Watanabe, 1934. Insecta matsum. 8(4):204. - Watanabe, 1937. J. Fac. Agric. Hokkaido (imp.) Univ. 42(1):144.

Specimens examined: Chaochou, 3♀,3♂,26.III.1982; 10♀,2♂, 7.IV.1982 ex. *Cnaphalocrocis medinalis* on rice (CCC). Chengkung, 12♀,23♂, 16-17.IX.1982 (KCC & CNL). Chihshan, 3♂, 25.III.1982 (KCC & CCP). Hsilo, 1♀,1♂, 8.X.1981 ex. *Cnaphalocrocis medinalis* on rice (CCC). Fuli-Tungho, 2♀, 9-11.XI.1982 (KCC & SPH). Liukuei, 1♂, 27-28. VI.1981 (LYC & CHY). Kenting, 1♂, 25-28.V.1982 (KCC & CCP); 2♂, 2-6.VIII.1982 (KCC & CNL). Maolin, 1♂, 26.III.1982 (KCC & CCP). Ouluanpi, 1♀, 25-28.V.1982 (KCC & CCP); 2♂, 5.VIII.1982 (KCC & CNL); 2♂, 12-16.III.1984 (KCC & CCP). Taipei, 2♀, 4♂ VII.1971 (KSL); 1♀, 1♂,2. X.1972 (KSL); 4♀, VIII.1975 (KSL); 1♂, X.1975 (KSL). Wanfeng, 46♀, 20♂, VII-X.1984 (

KSL & KCC); Wushe, 2♂, 14.VII.1982 (SCL & CNL).

Distribution: Java and Taiwan.

Host: *Cnaphalocrocis medinalis* (Guenée)[7,8].

Cardiochiles szepligeti Enderlein (Fig. 2).

Cardiochiles szepligeti Enderlein, 1906. Stettin. ent. Ztg. 67:252. - Watanabe, 1934. Insecta matsum. 8(4):205. - Watanabe, 1937. J. Fac. Agric. Hokkaido (imp.) Univ. 42(1):144.

Cardiochiles testaceus Szépligeti, 1902. Természetr. Füz. 25:77 (not Kriechbaumer, 1894).

Specimens examined: Chiasien, 1♂, 10-13.V.1981 (CCC & CCP). Liukuei, 1♀, 27-28.VI. 1981 (LYC & CHY). Meishan, 3♀,2♂, 29-30.1X.1967 (KCC). Wanfeng, 4♀,7♂, VII-VIII. 1984 (KSL & KCC). Wufeng, 2♂, 14-16.VII.1982 (KCC & CCP).

Distribution: Java, Malaysia, Singapore, Sri Lanka and Taiwan.

Host: Unknown.

Genus *Hartemita* Cameron

Hartemita Cameron, 1910. Wien. ent. Ztg. 29:99. Tye species: *Hartemita latipes* Cameron, by monotypy. - Dangerfield & Austin, 1990. J. Nat. Hist. 24:138.

Laminitarsus Fullaway, 1919. J. Straits Brch R. Asiat. Soc. 80:57. Type species: *Laminitarsus muirii* Fullaway, by monotypy.

The genus *Hartemita* is characterized by the following combination of characters: eyes mostly bare; cell 1M of fore wing equidimensional in shape; hind basitarsus flattened or laminate; hypopygium broadly rounded posteriorly; ovipositor very short and strongly down-curved; ovipositor sheath very short and directed ventrally. It contains 9 species in the world, including 2 species in Taiwan[10].

Key to species of the genus *Hartemita* form Taiwan

1. Hind basitarsus flattened, 3.7-3.9 times as long as wide, no wider than distal part of hind tibia; vertex largely smooth ········· *latipes* Cameron

-. Hind basitarsus broadly laminate, about 2.9 times as long as wide, distinctly wider than distal part of hind tibia; vertex weakly strigate medially ········· *townesi* Dangerfield & Austin

Hartemita latipes Cameron (Fig. 3)

Hartemita latipes Cameron, 1910. Wien. ent. Ztg. 29:99. - Dangerfield & Austin, 1990. J. Nat. Hist. 24:141.

Cardiochiles latipes (Cameron): Mao, 1949. Proc. U.S. natn. Mus. 99:230.

Specimens examined: Lienhuachih, 2♂, IX.1984 (KSL & KCC). Shuiyuan, 1♀, 12.VII. 1939 (JS). Sunmoon lake, 1♂, 20-27.IV.1970 (malaise trap). Tungpu, 1♀, X.1985 (KSL).

Distribution: Nepal and Taiwan.

Host: Unknown.

Hartemita townesi Dangerfield & Austin
(Fig. 4)

Hartemita townesi Dangerfield & Austin, 1990. J. Nat. Hist. 24:150.

Specimen examined: Lienhuachih, 1♂, IX.1984 (KSL & KCC).

Distribution: Nepal, Sumatra and Taiwan.

Host: Unknown.

Subfamily ORGILINAE

The Orgilinae are characterized by the following combination of characters: occipital carina usually present; without vein fold between vein 1/Rs and stigma; vein r-m of fore wing usually absent, if present, then cell 1+2Rs triangular (except *Antestrix* van Achterberg); fore wing without anal crossvein; vein 2cu-a of fore wing present; metatibia with apical pegs or spines; dorsope absent. This subfamily consist of 3 tribes, 11 genera[1,3,5,6,15]. Only the genus *Stantonia* Ashmead has been known to occur in Taiwan. In this paper 2 genera, *Orgilonia* van Achterberg and *Orgilus* Haliday, are added to the fauna of Taiwan.

Key to tribes and genera of Orgilinae from Taiwan

1. Vein r-m of fore wing present or absent; vein M+Cu of hind wing much shorter than vein 1/M; posterior margin of hind wing concave subbasally (Figs. 5-7) ································ Tribe Mimagathidini, 2

-. Vein r-m of fore wing absent; vein M+Cu of hind wing subequal to vein 1/M or longer; posterior margin of hind wing convex or nearly straight subbasally (Figs. 8-21) ································ Tribe Orgilini, *Orgilus* Haliday

2. Occipital carina absent; vein r-m of fore wing absent (Fig. 7) ··· *Orgilonia* van Achtererg

-. Occipital carina reaching upper level of eye; vein r-m of fore wing present (Figs. 5-6) ································ *Stantonia* Ashmead

Tribe Mimagathidini Enderlein

The tribe Mimagathidini is characterized by the following combination of characters: vein r-m of fore wing present, reduced to unsclerotized vein or absent; vein M+Cu of hind wing much shorter than vein 1/M; vein Cu&cu-a of hind wing strongly reclivous; posterior margin of hind wing concave subbasally. It consists of 3 genera, *Bentonia* van Achterberg, *Orgilonia* van Achterberg and *Stantonia* Ashmead. The latter two genera occur in Taiwan.

Genus **Orgilonia** van Achterberg

Orgilonia van Achterberg, 1987. Zool. Verh. Leiden 242:13. Type species: *Orgilonia fuscistigma* van Achterberg, by original designation.

The genus *Orgilonia* is characterized by the following combination of characters: occipital carina absent or only up to middle level of eye; vein r-m of fore wing absent; third and fourth metasomal terga with sharp lateral crease. It contains 4 species in the world. In this paper one new species is described from Taiwan.

Orgilonia chuchiensis sp. n.
(Fig. 7)

Orgilus sp. Chiu, Chou and Chou. 1981. J. Agric. Res. China 30(4):423.

Female: Head: 1.8 times as wide as long and 1.5 times wider than mesonotum. Eye 4.8 times as long as temple in dorsal view, eye height 1.4 times eye length in lateral view. Temples coriaceous; gradually narrow behind eyes. Frons granulate-coriaceous; glabrate medially. POL: OD: OOL=1: 0.86: 1.6. Vertex granulate-coriaceous. Face and clypeus combined 0.97 times as high as wide and 0.94 times as wide as eye height and 0.54 times as wide as head; face coriaceous; clypeus slightly coriaceous. Tentorial index 0.75. Malar space 1.1 times basal width of mandible and 0.26 times eye height. Length of maxillary palp 1.6 times height of head. Remaining antennal segments 30; first flagellomere 1.2 times as long as second; length of first and second flagellomeres 4.2 and 3.4 times their width, respectively.

Mesosoma: 1.8 times as long as high; largely granulate-coriaceous. Pronotal side crenulate medio-anteriorly. Notauli deep, crenulate. Epicnemial carina lightly indicated and not reaching anterior margin of mesopleuron; precoxal sulcus absent anteriorly, shallowly impressed posteriorly.

Wings: Fore wing: Stigma 4.8 times as long as wide; basal posterior section of stigma 1.1 times apical posterior section of stigma; r-rs: 3+4/Rs: 2/Rs=1: 9.2: 1.9; r-rs 0.87 times as long as stigma width; length of vein R1 9.0 times fore wing length from apex of cell 2Rl to wing apex; 2+3/M absent; lcu-a almost interstitial. Hind wing 8.2 times as long as wide.

Hind leg: Coxa granulate-coriaceous. Length of femur, tibia and basitarsus about 5.5, 12.9 and 9.6 times their width, respectively; tibial spurs 0.40 and 0.27 times as long as basitarsus.

Metasoma: First tergum 2.3 times as long as wide apically, dorsal carinae absent; second and third terga combined 2.4 times as long as wide at second metasomal suture; second metasomal suture wide and weakly crenulate. Basal four terga densely reticulate-punctate; rest terga coriaceous. Second, third and anterior fouth terga with sharp lateral crease. Ovipositor sheath 1.8 times as long as fore wing and 5.5 times as long as metafemur.

Color: Dark brown; clypeus ventrally and tegula brownish yellow, mandible (except for dark brown apex) and palpi yellow, anterior margins of basal three metasomal terga, lateral

and apical margins of second metasomal tergum yellow to brownish yellow. Antenna dark brown; scape, pedicel and flagellomeres 9-12 brownish yellow. Wings hyaline; stigma and veins dark brown. Legs largely brownish yellow. Ovipositor sheath dark brown.

Length: Body 4.8 mm, antenna 4.1 mm, fore wing 3.3 mm, ovipositor sheath 6.0 mm.

Male: Unknown.

Specimen examined: Holotype ♀, Chuchi, 21.X.1978 (LYC).

Distribution: Taiwan.

Host: Reared from unknown host which associated with lac sticks[9].

Remarks: This species is characterized by the following combination of characters: occipital carina completely absent; basal four metasomal terga densely reticulate-punctate; first metasomal tergum 2.3 times as long as wide apically, dorsal carinae absent; ovipositor sheath 1.8 times as long as fore wing.

Etymology: Named for the type locality, Chuchi.

Genus *Stantonia* Ashmead

Stantonia Ashmead, 1904. Proc. U.S. natn. Mus. 28:146. Type species: *Stantonia flava* Ashmead, by monotypy. - van Achterberg, 1987. Zool. Verh. Leiden 242:20.

Mimagathis Enderlein, 1905. Zool. Anz. 28:450. Type species: *Mimagathis ashmeadi* Enderlein, by subsequent designation, designated by Viereck, 1914. - Viereck, 1914. Bull. U.S. natn. Mus. 83:95.

The genus *Stantonia* is characterized by the following combination of characters: occipital carina lamelliform, reaching upper level of eye; scutellum evenly convex; vein r-m of fore wing usually present; third and fourth metasomal terga without sharp lateral crease. It contains about 40 species in the world, including 2 species in Taiwan[17]. In this paper one species, *Stantonia ruficornis* Enderlein, is added to the fauna of Taiwan.

Key to species of the genus *Stantonia* from Taiwan

1. Vein r-m of fore wing curved outwardly, but not bent ········· 2

-. Vein r-m of fore wing bent at upper third ········· *sauteri* Watanabe

2. Ovipositor sheath 0.52-0.58 times as long as fore wing length; propodeum coarsely rugose posteriorly; tegula brownish yellow; mesoscutum without dark brown pattern ········· *issikii* Watanabe

-. Ovipositor sheath 0.17-0.19 times as long as fore wing length; propodeum largely smooth to with some weaker rugae; tegula almost always dark brown apically; mesoscutum almost always with dark brown pattern ········· *ruficornis* Enderlein

Stantonia issikii Watanabe
(Fig. 5)

Stantonia issikii Watanabe, 1932. Insecta matsum. 6(4):187. - van Achterberg, 1987. Zool. Verh. Leiden 242:22

Microtypus issikii (Watanabe): Watanabe, 1937. J. Fac. Agric. Hokkaido (imp.) Univ. 42(1):95.

Specimens examined: Lienhuachih, 1♀, IX.1984 (KSL & KCC); 1♀, XII.1984 (KSL & KCC). Tainan 1♀, 18.VII.1935 (JS). Wanfeng, 1♀, XI.1984 (KSL & KCC).

Distribution: Taiwan.

Host: Unknown.

Stantonia ruficornis Enderlein
(Fig. 6)

Stantonia ruficornis Enderlein, 1921. Wien. ent. Ztg. 38:58. - van Achterberg, 1987. Zool. Verh. Leiden 242:24.

Specimens examined: Meifeng, 1♂, 4-7.X.1982 (KCC). Tungpu, 1♀, 25-29.IX.1980 (LYC & TL); 1♂, 22-25.XI.1982 (KCC & SPH) ; 1♀, 10-14.I.1983 (KCC & SPH); 6♀, X-XII.1985 (KSL).

Distribution: Mainland China, Taiwan (new record)and Viet Nam.

Host: Unknown.

Stantonia sauteri Watanabe

Stantonia sauteri Watanabe, 1932. Insecta matsum. 6(4):188. - van Achtergerg, 1987. Zool. Verh. Leiden 242:24.

Microtypus sauteri (Watanabe): Watanabe, 1937. J. Fac. Agic. Hokkaido (imp.) Univ. 42(1):95.

Specimen examined: Specimen was not available to study.

Distribution: Taiwan.

Host: Unknown.

Tribe Orgilini Ashmead

The tribe Orgilini is characterized by the following combination of characters: vein r-m of fore wing usually absent; vein M+Cu of hind wing subequal to vein 1/M or longer; vein Cu&cu-a of hind wing usually vertical or weakly reclivous; posterior margin of hind wing nearly straight or convex subbasally. It consists of 7 genera[1,5,6]. Only the genus *Orgilus* Haliday occurs in Taiwan.

Genus Orgilus Haliday

Orgilus Haliday, 1833. Ent. Mag. 1:262. Type species: *Microdus obscurator* Nees, by monotypy. - van Achterberg, 1987. Zool. Verh. Leiden 242:55. - Taeger, 1989. Akad. Landwirtschaftswiss. DDR :24.

Ischius Wesmael, 1837. Nouv. Mem. Acad. Brux. 10:20. Type species: *Microdus obscurator*

Nees, by subsequent designation, designated by Viereck, 1914. - Viereck, 1914. Bull. U. S. natn. Mus. 83:77.

Macropalpus Ratzeburg, 1844. Ichn. d. Forstins. 1:56. Type species: *Eubadizon leptocephalus* Hartig, by monotypy.

Oresimus Ashmead, 1900. Proc. U.S. natn. Mus. 23:123. Type species: *Eubadizon maculiventris* Cresson, by monotypy.

Orgilomorpha Ashmead, 1900. Proc. U.S. nstn. Mus. 23:123. Type species: *Ganychorus gelechiae* Ashmead, by monotypy.

Orgilus (*Ischiolus*) Hellén, 1958. Soc. Fauna Flora Fennica 4:34. Type species: *Microgaster rugosus* Nees, by monotypy. - van Achterberg, 1987. Zool. Verh. Leiden 242:55.

The genus *Orgilus* is characterized by the following combination of characters: clypeus without tubercles; stemmaticum situated in a largely flat or convex area; scutellum without depression medio-posteriorly; vein 1/Rs of fore wing absent; first metasomal tergum (sub)-sessile and usually concave basally; second and third metasomal terga without X-shaped depression. It consists of 4 subgenera[15], and about 220 species in the world. In this paper 13 new species are described from Taiwan. All of these species belong to the subgenus *Orgilus* Haliday. The subgenus *Orgilus* is characterized by the epicnemial carina present; and occipital carina present laterally, at least as a short stub.

Key to species of the genus *Orgilus* from Taiwan

1. Vein 2+3/M of fore wing subequal to 2/Rs+M, or longer (Figs. 8-13); malar space 1.3-2.4 times basal width of mandible ······ 2
-. Vein 2+3/M of fore wing wanting or short, usually at most about 0.5 times as long as 2/Rs+M (Figs. 14-21); malar space 0.9-1.1 times basal width of mandible ······ 7
2. Face and clypeus combined 1.4-1.5 times as high as wide; malar space 1.9-2.4 times basal width of mandible ······ 3
-. Face and clypeus combined 1.0-1.1 times as high as wide; malar space 0.88-1.6 times basal width of mandible ······ 4
3. Third metasomal tergum largely rugose-reticulate; tentorial index 0.36-0.38 ······ *parapappianus* sp. n.
-. Third metasomal tergum at least largely smooth medially; tentorial index 0.46-0.58 ······ *caballus* sp. n.
4. Ovipositor sheath almost as long as fore wing length; antenna 40-segmented; second and third metasomal terga combined 1.6 times as long as wide at second metasomal suture ······ *amplissimus* sp. n.
-. Ovipositor sheath about 0.42-0.73 times as long as fore wing length; antenna 29-30-segmented; second and third metasomal terga combined 1.2-1.3 times as long as wide at second metasomal suture ······ 5
5. Third metasomal tergum closely punctate anteriorly; mesosoma 1.8 times as long as high; mesopleuron largely coriaceous-granulate ······ *ischnus* Marshall

-. Third metasomal tergum largely smooth; mesosoma 1.4-1.6 times as long as high; mesopleuron punctulate 6

6. Second metasomal tergum densely punctate anteriorly; ovipositor sheath about 0.72 times as long as fore wing length .... *taiwanensis* sp. n.

-. Second metasomal tergum only with few small punctures; ovipositor sheath about 0.42 times as long as fore wing length .... *planus* sp. n.

7. Head densely punctulate or punctate; second metasomal tergum reticulate-rugose or costate 8

-. Head coriaceous or granulate-coriaceous; second metasomal tergum closely punctate or punctate-reticulate 10

8. Third metasomal tergum with complete sharp lateral crease .... *cunctus* sp. n.

-. Third metasomal tergum without complete sharp lateral crease, absent apically........ 9

9. Ovipositor sheath 1.2-1.3 times as long as fore wing length; first metasomal tergum 1.3-1.5 times as long as wide apically .... *rarus* sp. n.

-. Ovipositor sheath 0.59-0.63 times as long as fore wing length; first metasomal tergum almost as long as wide apically........ *improcerus* sp. n.

10. Antenna 21-25-segmented; tentorial index 0.89-1.0; length of vein R1 4.9-5.2 times fore wing length from apex of cell 2R1 to wing apex .... *galbinus* sp. n.

-. Antenna 29-33-segmented; tentorial index 0.58-0.77; length of vein R1 9.2-10.2 times fore wing length from apex of cell 2R1 to wing apex 11

11. Dorsal surface of head, mesosoma and metasoma largely blackish brown to black 12

-. Dorsal surface of head, mesosoma and metasoma largely brownish yellow 13

12. Second and third metasomal terga combined 0.87 times as long as wide at second metasomal suture; mesosoma 1.4 times as long as high; antenna 29-segmented .... *lini* sp. n.

-. Second and third metasomal terga combined 1.2 times as long as wide at second metasomal suture; mesosoma 1.7 times as long as high; antenna 33-segmented .... *cretus* sp. n.

13. First metasomal tergum largely glabrous between dorsal carinae; basal posterior section of stigma 1.6 times apical posterior section of stigma; fore wing vein r-rs: 3+4/Rs: 2/Rs about 1: 8.6: 2.4; .... *meifengensis* sp. n.

-. First metasomal tergum largely sculptured between dorsal carinae; basal posterior section of stigma 1.3-1.4 times apical posterior section of stigma; fore wing vein r-rs: 3+4/Rs: 2/Rs about 1: 6.8: 1.9; .... *caritus* sp. n.

Orgilus amplissimus sp. n.

(Figs. 8, 23, 38, 52, 66, 80, 96, 111, 124, 149)

Female: Head: 1.5 times as wide as long and 1.2 times wider than mesonotum. Eye 1.4 times as long as temple in dorsal view, eye height 1.7 times eye length in lateral view. Temple densely punctate. Frons strigate medioventrally, smooth mediodorsally, densely punctate laterally. POL: OD: OOL=1: 0.80: 1.7. Vertex densely punctate. Face and clypeus combined

1.0 times as high as wide and 1.2 times as wide as eye height and 0.61 times as wide as head; convex, densely punctate. Tentorial index 0.52. Malar space 1.4 times basal width of mandible and 0.44 times eye height. Length of maxillary palp 1.1 times height of head. Antenna 40-segmentde; first flagellomere 1.4 times as long as second; length of first, second and penultimate flagellomeres 2.6, 1.8 and 0.88 times their width, respectively.

Mesosoma: 1.6 times as long as high. Pronotal side rather densely punctulate dorsally; reticulate-rugose medially; densely punctulate ventrally. Notauli well impressed, crenulate; mesoscutum densely punctate, scutellum rather densely punctulate. Mesopleuron rather densely punctulate above precoxal sulcus, densely punctulate below precoxal sulcus; precoxal sulcus crenulate. Metapleuron rather densely punctate, rugose ventrally. Propodeum largely rugose-reticulate, smooth anterolaterally.

Wings: Fore wing: Stigma 4.1 times as long as wide; basal posterior section of stigma 1.4 times apical posterior section of stigma; r-rs: 3+4/Rs: 2/Rs=1: 4.8: 1.6; r-rs 1.2 times as long as stigma width; length of vein R1 2.3 times fore wing length from apex of cell 2R1 to wing apex; 2+3/M 1.6 times as long as 2/Rs+M; lcu-a postfurcal. Hind wing 4.8 times as long as wide.

Hind leg: Coxa rugose dorsally. Length of femur, tibia and basitarsus about 4.3, 8.6 and 8.2 times their width, respectively; tibial spurs 0.49 and 0.32 times as long as basitarsus.

Metasoma: Basal three metasomal terga largely smooth; second metasomal tergum with some distinct punctures antero-sublaterally. First tergum 1.5 times as long as wide apically, dorsal carinae absent. Second and third terga comgbined 1.6 times as long as wide at second metasomal suture; second metasomal suture distinct, smooth; lateral crease of third tergum only distinct anteriorly. Ovipositor sheath almost as long as fore wing and 5.6 times as long as metafemur.

Color: Black; palpi blackish brown, basal first metasomal tergum, second metasomal tergum and anterior third metasomal tergum reddish, posterior metasomal tergum dark brown. Antenna blackish brown. Wings faintly brownish hyaline; stigma and veins dark brown. Legs reddish brown; procoxa, mesocoxa, basal metacoxa, trochanters, apical metafemur, metatibia and tarsi dark brown to blackish brown, metatibial spurs reddish brown. Ovipositor sheath blackish brown.

Length: Body 6.2 mm, antenna 5.4 mm, fore wing 4.7 mm, ovipositor sheath 4.6 mm.

Male: Unknown.

Specimen examined: Holotype: ♀, Tayuling, 12-15.IX.1980 (KSL & CHW).

Distribution: Taiwan.

Host: Unknown.

Remarks: This species can be easily descriminated from the other Taiwanese species of the genus *Orgilus* by the ovipositor sheath almost as long as fore wing and the antenna with 40 segments.

Etymology: *Amplissimus* means larger in Latin, refers to its larger body length.

Orgilus caballus sp. n.
(Figs. 9, 22, 36, 51, 64, 78, 94, 109, 122, 136, 151)

Female: Head: 1.6 times as wide as long and 1.0-1.1 times wider than mesonotum. Eye 1.3-1.4 times as long as temple in dorsal view, eye height 1.9 times eye length in lateral view. Temple densely punctulate; gena coriaceous-granulate to rugose ventrally. Frons largely glabrous medially, densely punctulate laterally. POL: OD: OOL=1: 0.86-0.92: 2.1-2.3. Vertex densely punctulate. Face and clypeus combined 1.4-1.5 times as high as wide and 0.90-0.94 times as wide as eye height and 0.53 times as wide as head; face convex, densely punctulate; clypeus strongly convex, sparsely punctulate. Tentorial index 0.46-0.58. Malar space 1.9-2.0 times basal width of mandible and 0.44-0.45 times eye height. Length of maxillary palp 0.7 times height of head. Antenna 27-segmented; first flagellomere 0.95-1.1 times as long as second; length of first, second and penultimate flagellomeres 2.4-2.9, 2.5-2.8 and 1.2-1.3 times their width, respectively.

Mesosoma: 1.5 times as long as high. Pronotal side rather densely punctulate dorsally, rugose-reticulate ventrally. Notauli well impressed, crenulate; mesoscutum densely punctate; scutellum rather densely punctate. Mesopleuron largely rather sparsely punctate above precoxal sulcus, densely punctulate below precoxal sulcus, precoxal sulcus crenulate. Metapleuron rather densely punctulate Propodeum rather densely punctulate to punctate, rugose-reticulate medially and around spiracle.

Wings: Fore wing: Stigma 3.1 times as long as wide; basal posterior section of stigma 1.1 times apical posterior section of stigma; r-rs: 3+4/Rs: 2/Rs=1: 5.2-5.8: 1.4-1.6; r-rs 0.86 times as long as stigma width; length of vein R1 6.1-6.5 times fore wing length from apex of cell 2R1 to wing apex; 2+3/M 1.3 times as long as 2/Rs+M; 1cu-a postfurcal. Hind wing 4.0-4.4 times as long as wide.

Hind leg: Coxa rather rugulose dorsally. Length of femur, tibia and basitarsus about 4.3-4.4, 7.4-8.2 and 8.6-8.8 times their width, respectively, tibial spurs 0.50-0.57 and 0.36-0.38 times as long as basitarsus.

Metasoma: First tergum 0.77-0.83 times as long as wide apically, rugose-reticulate, dorsal carinae distinct in basal half. Second and third terga combined 0.88 times as long as wied at second metasomal suture; second tergum rugose-reticulate; second metasomal suture deep and wide, crenulate; third tergum largely smooth medially, more or less rugose laterally, with complete sharp lateral crease, but more or less weak apically. Ovipositor sheath 0.57-0.63 times as long as fore wing and 2.0-2.3 times as long as metafemur.

Color: Black; mandible and tegula dark brown, palpi yellowish brown. Antenna black. Wings hyaline; stigma and veins dark brown. Legs yellowish brown; apex of mesofemur, fore and middle tibiae and tarsi more or less dark brown; basal metacoxa, apical metafemur and metatarsus blackish brown, basal 0.6 of metatibia more or less lighter. Ovipositor sheath black.

Length: Body 3.8-3.9 mm, antenna 3.4-3.5 mm, fore wing 3.8-4.0 mm, ovipositor sheath 2.2-2.5 mm.

Male: Similar to female. Antenna 26-28-segmented.

Specimens examined: Holotype: ♀, Tsuifeng, 27.VIII.1981 (LYC & SCL). Paratypes: Meifeng, 1♀, 26.VIII.1980 (KSL & CHW); 1♀, 15.VII.1982 (SCL & CNL). Tayuling, 8♀, 1 ♂, 12-15.IX.1980 (KSL & CHW); 4♀, 6-9.IX.1983 (LYC & KCC). Tsuifeng, 1♀, 27.VIII.1981 (LYC & SCL); 4♂, 1-3.IX.1982 (LYC & KCC); 1♀, 15-16.VIII.1984 (KCC); 3♀, 1♂, 12-14. IX.1984 (KSL & SCL). Wuling, 1♂, 27-29.VI.1979 (KSL & LYC).

Distribution: Taiwan.

Host: Unknown.

Remarks: This species is close to *O. parapappianus* sp. n., but differs from it by the third metasomal tergum largely smooth medially and the gena wider ventrally.

Etymology: *Caballus* means horse in Latin, refers to its longer face.

Orgilus caritus sp. n.

(Figs. 14, 34, 48, 62, 76, 92, 106, 120, 134, 147, 156)

Female: Head: 1.6 times as wide as long and 1.1 times wider than mesonotum, granulate-coriaceous. Eye 2.4-2.5 times as long as temple in dorsal view, eye height 1.5 times eye length in lateral view. POL: OD: OOL=1: 1.0: 2.5. Face and clypeus combined 0.97-1.0 times as high as wide and 1.1-1.2 times as wide as eye height and 0.60 times as wide as head; convex. Tentorial index 0.67. Malar space 1.0 times basal width of mandible and 0.29-0.30 times eye height. Length of maxillary palp 0.9 times height of head. Antenna 29-segmented; first flagellomere 1.2 times as long as second; length of first, second and penultimate flagellomeres 3.2-3.5, 2.7-2.9 and 2.0 times their width, respectively.

Mesosoma: 1.5-1.6 times as long as high. Pronotal side coriaceous dorsally, crenulate medioanteriorly, granulate-coriaceous ventrally. Notauli well impressed, crenulate; mesonotum granulate-coriaceous. Mesopleuron largely coriaceous, except largely smooth anteroventrally above precoxal sulcus; precoxal sulcus weakly crenulate. Metapleuron and propodeum coriaceous.

Wings: Fore wing: Stigma 3.8-3.9 times as long as wide; basal posterior section of stigma 1.3-1.4 times apical posterior section of stigma, r-rs: 3+4/Rs: 2/Rs=1: 6.7-6.8: 1.8-1.9; r-rs 0.90 times as long as stigma width; length of vein R1 9.9-10.2 times fore wing length from apex of cell 2R1 to wing apex; 2+3/M absent; 1cu-a postfurcal. Hind wing 4.9-5.0 times as long as wide.

Hind leg: Coxa granulate-coriaceous. Length of femur, tibia and basitarsus about 3.8, 7.4-7.8 and 8.3-9.0 times their width, respectively; tibial spurs 0.50-0.51 and 0.33-0.34 times as long as basitarsus.

Metasoma: First tergum 1.1-1.2 times as long as wide apically, costulate, interspace punctate, dorsal carinae distinct in basal half. Second and third terga combined 1.0-1.1 times as long as wide at second measomal suture; second and third terga punctate-reticulate; second metasomal suture deep and wide, crenulate; third tergum with complete sharp lateral crease; fourth tergum densely punctulate. Oviposior sheath 0.30-0.33 times as long as fore wing and 1.1-1.3 times as long as metafemur.

Color: Brownish yellow, stemmaticum black, tegula yellow. Antenna yellowish brown to brown. Wings hyaline; stigma largely brownish yellow; margin of stigma, and veins brown. Legs brownish yellow; metafemur brown subbasally and apically, metatibial spurs yellow, tarsi light brown to brown, basal metatarsomere 1 lighter. Ovipositor sheath brown.

Length: Body 3.3-3.9 mm, antenna 3.5 mm, fore wing 3.2-3.5 mm, ovipositor sheath 1.1 mm.

Male: Unknown.

Specimens examined: Holotype: Chihpen, 1♀, 15-17.II.1981 (LYC & TL). Paratypes: Tungpu, 1♀, 28.IV-2.V.1981 (TL & CJL); 1♀, 5-8.X.1981 (TL & WST).

Distrbution: Taiwan.

Host: Unknown.

Remarks: This species is close to *O. meifengensis* sp. n., but differs from it by the first metasomal tergum largely sculptured between dorsal carinae, basal posterior section of stigma 1.3-1.4 times apical posterior section of stigma and the fore wing wein r-rs: 3+4/Rs: 2/Rs about 1: 6.8: 1.9.

Etmology: *Caritus* means lacking in Latin, refers to its fore wing vein 2+3/M absent.

Orgilus cretus sp. n.

(Figs. 15, 31, 46, 60, 74, 90, 104, 118, 132, 145)

Female: Head: 1.5 times as wide as long and 1.2 times wider than mesonotum, granulate-coriaceous. Eye 2.0 times as long as temple in dorsal view, eye height 1.4 times eye length in lateral view. POL: OD: OOL=1: 1.0 : 2.2 Face and clypeus combined 1.1 times as high as wide and 1.2 times as wide as eye hieght and 0.58 times as wide as head; convex. Tentorial index 0.73. Malar space 0.88 times basal width of mandible and 0.26 times eye height. Length of maxillary palp 0.9 times height of head. Antenna 33-segmented; first flagellomere 1.2 times as long as second; length of first, second and penultimate flagellomeres 3.6, 2.9 and 2.1 times their width, respectively.

Mesosoma: 1.7 times as long as high. Pronotal side coriaceous dorsoposteriorly, smooth dorsoanteriorly, crenulate medioanteriorly, granulate-coriaceous ventrally. Notauli well impressed, crenulate; mesoscutum granulate-coriaceous, scutellum coriaceous. Mesopleuron smooth to faintly coriaceous above precoxal sulcus, faintly coriaceous below precoxal sulcus; precoxal sulcus punctate. Metapleuron faintly coriaceous. Propodeum smooth to faintly coriaceous.

Wings: Fore wing: Stigma 3.9 times as long as wide; basal posterior section of stigma 1.6 times apical posterior section of stigma; r-rs: 3+4/Rs: 2/Rs=1: 9.0: 2.4; r-rs 0.70 times as long as stigma width; length of vein R1 9.7 times fore wing length from apex of cell 2R1 to wing apex; 2+3/M absent; lcu-a weakly postfurcal. Hind wing 5.7 times as long as wide.

Hind leg: Coxa rather granulate-coriaceous. Length of femur, tibia and basitarsus about 4.2, 8.8 and 8.7 timnes their width, respectively; tibial spurs 0.48 and 0.35 times as long as basitarsus.

Metasoma: First tergum 1.3 times as long as wide apically, densely punctate, with some

rugae laterally, dorsal carinae distinct in basal half. Second and third terga combined 1.2 times as long as wide at second metasomal suture, second tergum densely punctate; second metasomal suture deep and wide, crenulate; third tergum more or less densely punctate anteriorly, smooth posteriorly, with complete sharp lateral crease. Ovipositor sheath 0.35 times as long as fore wing and 1.4 timnes as long as metafemur.

Color: Yellowish brown; frons and vertex medially, mesonotum, propodum, and metasoma largely dark brown. Antenna dark brown. Wings hyaline; stigma largely yellowish brown; margin of stigma, and veins brown. Legs yellowish brown; metatibia dark brown subbasally and apically, metatibial spurs yellowish brown, tarsi dark brown. Ovipositor sheath dark brown.

Length: Body 3.5 mm, antenna 4.5 mm, fore wing 3.6 mm, ovipositor sheath 1.3 mm.

Male: Unknown.

Specimen examined: Holotpe: Meifeng, 1♀, 28-29.VIII.1981 (LYC & SCL).

Distribution: Taiwan.

Host: Unknown.

Remarks: This species is close to *O. lini* sp. n., but differs from it by the second and third metasomal terga combined 1.2 times as long as wide at second metasomal suture, mesosoma 1.7 times as long as high and the antenna 33-segmented.

Etymology: *Cretus* means separate in Latin, refers to its second metasomal suture deep and wide.

Orgilus cunctus sp. n.

(Figs. 16, 27, 42, 56, 70, 86, 100, 116, 128, 141, 154)

Female: Head: 1.6-1.7 times as wide as long and 1.2-1.3 times wider than mesonotum. Eye 1.8-2.0 times as long as temple in dorsal view, eye height 1.6 times eye length in lateral view. Temple and vertex rather densely punctulate. Frons largely glabrous medially, rather densely punctulate laterally. POL: OD: OOL=1: 0.91: 2.2. Face and clypeus 1.0 times as high as wide and 1.1 times as wide as eye height and 0.55 times as wide as head; face convex, rather densely punctate; clypeus strongly convex, rather sparsely punctulate. Tentorial index 0.57-0.60. Malar space 1.0 times basal width of mandible and 0.28-0.29 times eye height. Length of maxillary palp 1.0 times height of head. Antenna 25-segmented; first flagellomere 0.97-1.1 times as long as second; length of first, second and penultimate flagellomeres 2.6-3.1, 2.7-2.9 and 1.5 times their width, respectively.

Mesosoma: 1.8 times as long as high. Pronotal side largely smooth dorsally, weakly crenulate medially, rather granulate-coriaceous ventrally, Notauli well impressed, crenulate; mesoscutum rather densely punctate; scutellum sparsely punctulate. Mesopleuron rather densely punctulate; precoxal sulcus weakly crenulate. Metapleuron rather densely punctate. Propodeum largely reticulate-rugose, smooth apically.

Wings: Fore wing: Stigma 3.2 timnes as long as wide; basal posterior section of stigma 1.2-1.3 times apical posterior section of stigma; r-rs: 3+4/Rs: 2/Rs=1: 6.2-6.8: 1.5-1.6; r-rs 0.79 times as long as stigma width; length of vein R1 9.4-9.7 times fore wing length from

apex of cell 2R1 to wing apex; 2+3/M faintly indicated, 0.2 times as long as 2/Rs+M; 1cu-a postfurcal. Hind wing 4.4-4.6 times as long as wide.

Hind leg: Coxa rather granulate-coriaceous dorsally. Length of femur, tibia and basitarsus 4.2-4.4, 7.4-7.5 and 7.2-7.6 times their width, respectively; tibial spurs 0.47-0.58 and 0.33-0.34 times as long as basitarsus.

Metasoma: First tergum 1.0 times as long as wide apically, reticulate-rugose, smooth apically; dorsal carina distinct anteriorly. Second and third terga combined 1.2-1.4 times as long as wide at second metasomal suture. Second metasomal tergum reticulate-rugose; second metasomal suture deep and wide, crenulate; third tergum reticulate-rugose, smooth apically, with complete sharp lateral crease. Fourth and fifth terga densely punctate anteriorly. Ovipositor sheath 0.83-0.86 times as long as fore wing and 3.2 times as long as metafemur.

Color: Brownish yellow; frons and vertex brown medially, palpi brown, three lobes of mesoscutum, metanotum, propodeum and margins of metapleuron black; metasoma largely black, partely yellowish brown to dark brown. Antenna dark brown. Wings hyaline; stigma and veins dark brown. Legs brownish yellow; subbasal and apical metafemur dark brown, tarsi more or less dark brown; metatibia spurs yellow. Ovipossitor sheath dark brown.

Length: Body 2.9-3.0 mm, antenna 2.8 mm, fore wing 2.7-2.8 mm, ovipositor sheath 2.3-2.4 mm.

Male: Unknown.

Specimens examined: Holotype: ♀, Tungpu, 18-21.X.1982 (KCC & SCL). Paratype: Tungpu, 1♀, XI.1985 (KSL).

Distribution: Taiwan.

Host: Unknown.

Remarks: This species differs from the other Taiwanese *Orgilus* species by the following combination of characters: face and clypeus combined about 1.0 times as high as wide, third metasomal tergum with complete sharp lateral crease and ovipositor sheath about 0.8 times as long as fore wing length.

Etymology: *Cunctus* means all in Latin, refers to its third metasomal tergum with complete sharp lateral crease.

Orgilus galbinus sp. n.

(Figs. 17, 32, 45, 59, 73, 89, 103, 117, 131, 144, 155)

Female: Head: 1.6-1.7 times as wide as long and 1.3 times wider than mesonotum, coriaeous. Eye 2.3 times as long as temple in dorsal view, eye height 1.4 times eye length in lateral view. POL: OD: OOL=1: 1.3 : 2.8. Face and clypeus combined 0.93 times as high as wide and 1.2-1.3 times as wide as eye height and 0.59-0.60 times as wide as head, convex. Tentorial index 0.89-1.0. Malar space 0.88-1.0 times basal width of mandible and 0.30-0.35 times eye height. Length of maxillary palp 1.1-1.2 times height of head. Antenna 21-24-segmented; first flagellomere 1.2 times as long as second; length of first, second and penultimate flagellomeres 3.9-4.0, 3.2-3.3 and 2.3 times their width, respectively.

Mesosoma: 1.7 times as long as high, coriaceous. Pronotal side crenulate medioanteriorly. Notauli well impressed. Precoxal sulcus shallowly depressed.

Wings: Fore wing: Stigma 3.8 times as long as wide; basal posterior section of stigma 1.3-1.4 times apical posterior section of stigma; r-rs: 3+4/Rs: 2/Rs=1: 10.3-10.7: 2.8-2.9; r-rs 0.56 times as long as stigma width; length of vein R1 4.9-5.2 times fore wing length from apex of cell 2R1 to wing apex; 2+3/M absent; lcu-a usually interstitial, seldom antefurcal. Hind wing 5.4-5.7 times as long as wide.

Hind leg: Coxa coriaceous. Length of femur, tibia and basitarsus 4.1-4.3, 8.7-8.8 and 7.6-8.2 times their width, respectively; tibial spurs 0.51-0.53 and 0.32-0.35 times as long as basitarsus.

Metasoma: First tergum 1.1 times as long as wide apically, densely punctate, dorsal carinae distinct in basal half. Second and third terga combined 1.0-1.1 times as long as wide at second metasomal suture. Second tergum punctate-reticulate; second metasomal suture deep and wide, crenulate; third tergum faintly coriaceous anteriorly; lateral crease of third tergum only distinct anteriorly. Ovipositor sheath 0.40-0.42 times as long as fore wing and 1.5-1.6 times as long as metafemur.

Color: Brownish yellow; stemmaticum black. Antenna yellowish brown to dark brown. Wings hyaline; stigma and veins brownish yellow. Legs brownish yellow, metatibial spurs yellow. Ovipositor sheath yellowish brown to dark brown.

Length: Body 2.5-2.7 mm, antenna 3.0 mm, fore wing 2.6-2.7 mm, ovipositor sheath 1.1 mm.

Male: Similar to female.

Specimens examined: Holotype: ♀, Tungpu, XII.1985 (KSL). Paratypes: Meifeng, 1♀, 24-26.VI.1981 (KSL & WST). Shantimen. 1♀, 1-5.III.1982 (KCC & CCP); 1♀, 16-20.I.1984 (KCC & CCP). Tawu, 1♂, 12-14.II.1981 (LYC & TL). Tungpu, 2♀, 25-29.IX.1980 (LYC & TL); 2♀, 18-23.XI.1981 (TL & WST); 1♀, 19-23.VII.1982 (LYC & TL); 1♂, 18-21.X.1982 (KCC & SCL); 3♀, 22-25.XI.1982 (KCC & SPH); 1♀, 10-14.I.1983 (KCC & SPH); 11♀, X, 5♀, XI, 8♀, XII.1985 (KSL). Wushe, 1♀, 6.XI.1981 (SCL & WST).

Distribution: Taiwan.

Host: Unknown.

Remarks: This species is close to *Orgilus moczari* Papp[13], but differs from it by the sculpture of the first and second metasomal terga.

Etymology: *Galbinus* means yellowish in Latin, refers to its body coloration.

Orgilus improcerus sp. n.

(Figs. 18, 29, 43, 58, 71, 84, 88, 101, 110, 129, 142)

Female: Head: 1.7 times as wide as long and 1.2 times wider than mesonotum. Eye 2.1-2.4 times as long as temple in dorsal view, eye height 1.3-1.4 times eye length in lateral view. Temple and vertex rather densely punctulate. Frons glabrous medially, rather densely punctulate laterally, granulate-coriaceous near toruli. POL: OD: OOL=1: 1.1-1.3: 2.7-2.8. Face and clypeus combined 1.0 times as high as wide and 1.1-1.2 times as wide as eye height

and 0.54-0.56 times as wide as head; face slightly convex, densely punctate; clypeus convex, rather densely punctulate. Tentorial index 0.67-0.70. Malar space 1.0 times basal width of mandible and 0.30 times eye height. Length of maxillary palp 1.2 times height of head. Antenna 22-24-segmented; first flagellomere 1.0-1.1 timnes as long as second; length of first, second and penultimate flagellomeres 2.9-3.0, 2.6-3.0 and 1.4-1.5 times their width. respectively.

Mesosoma: 1.4-1.5 times as long as high. Pronotal side largely glabrous dorsally, crenulate medioanteriorly, coriaceous ventrally. Notauli well impressed, crenulate; mesoscutum densely punctate, scutellum rather densely punctate. Mesopleuron rather sparsely punctulate above precoxal sulcus, rather densely punctulate below precoxal sulcus; precoxal sulcus crenulate. Metapleuron rather densely punctulate. Propodeum largely smooth, rugulose to rugose medially.

Wings: Fore wing: Stigma 3.6 times as long as wide; basal posterior section of stigma 0.91-0.96 times apical posterior section of stigma; r-rs: 3+4/Rs: 2/Rs=1: 5.9-6.1: 1.5-1.6; r-rs almost as long as stigma width; length of vein R1 16.6-16.8 times fore wing length from apex of cell 2R1 to wing apex; 2+3/M faintly indicated, 0.2 times as long as 2/Rs+M; 1cu-a postfurcal. Hind wing 4.3-4.4 times as long as wide.

Hind leg: Coxa smooth. Length of femur, tibia and basitarsus 3.5-3.7, 7.8-8.5 and 6.7-7.2 times their width, respectively; tibial spurs 0.54-0.56 and 0.35-0.36 times as long as basitarsus.

Metasoma: First tergum 0.95 times as long as wide apically, costulate, interspace punctate, dorsal carinae distinct in basal half. Second and third terga combined 0.83-0.92 times as long as wide at second metasomal suture. Second tergum largely costulate, interspace punctate, lateral margin smooth; second metasomal suture deep and wide, crenulate; third tergum anteromedially costulate, interspace punctate, rest smooth; lateral crease of third tergum only distinct anteriorly. Ovipositor sheath 0.59-0.63 times as long as fore wing and 2.2 times as long as metafemur.

Color: Brownish yellow; stemmaticum and metasoma beyond second tergum dark brown, second metasomal tergum brownish yellow to dark brown. Antenna brownish yellow to dark brown. Wings hyaline; stigma and veins light brown. Legs brownish yellow. Ovipositor sheath dark brown.

Length: Body 2.8-3.0 mm, antenna 2.7 mm, fore wing 2.6-2.7 mm, ovipositor sheath 1.5-1.7 mm.

Male: Similar to female.

Specimens examined: Holotype: ♀, Lienhuachih, VIII.1984 (KSL & KCC). Paratypes: Kenting, 1♀, 18-23.III.1981 (KSL & TL); 1♀, 1♂, 24-28.VI.1981 (TL & CCP). Lienhuachih, 1♀, VIII.1984 (KSL & KCC); 1♀, 1♂, XI.1984 (KSL & KCC). Ouluanpi, 1♂, 23-25.III.1982 (TL & SCL); 2♂, 12-13.III.1984 (KCC & CCP). Wufeng, 2♂, 14-16.VII.1982 (KCC & CCP).

Distribution: Taiwan.

Host: Unknown.

Remarks: This species differs from the other Taiwanese *Orgilus* species by the following

combination of characters: antenna with 22-24 segments, vertex punctulate, face and clypeus combined about 1.0 times as high as wide, third metasomal tergum without complete sharp lateral crease and ovipositor sheath about 0.6 times as long as fore wing length.

Etymology: *Improcerus* means short in Latin, refers to its first metasomal tergum shorter.

Orgilus ischnus Marshall
(Figs. 10, 28, 39, 54, 67, 81, 97, 112, 125, 138, 152)

Orgilus ischnus Marshall, 1898. Spec. Hym. Eur. Alg. 5(2):197. - Taeger, 1989. Akad. Landwirtschaftswiss. DDR :104.

Orgilus subtilrugosus Papp, 1971. Acta Zool. Hung. 18:56.

Female: Head: 1.5 times as wide as long and almost as wide as mesonotum. Eye 1.7 times as long as temple in dorsal view, eye height 1.6 times eye length in lateral view. Temple, frons (except medially largely smooth) and vertex granulate-coriaceous. POL: OD: OOL=1: 0.50: 1.0. Face and clypeus combined 1.0 times as high as wide and 1.1 times as wide as eye height and 0.61 times as wide as head; strongly convex; face granulate-coriaceous, clypeus densely punctate. Tentorial index 0.67. Malar space 1.6 times basal width of mandible and 0.42 times eye height. Length of maxillary palp 1.1 times height of head. Antenna 31-segmented; first flagellomere 1.1 times as long as second; length of first, second and penultimate flagellomeres 2.8, 2.6 and 1.2 times their width, respectively.

Mesosoma: 1.8 times as long as high. Pronotal side largely granulate-coriaceus, rugose medially. Notauli well impressed, crenulate; mesoscutum coarsely granulate-coriaceous, scutellum granulate-coriaceous. Mesopleuron granulate-coriaceous, precoxal sulcus crenulate. Metapleuron largely granulate - coriaceous, rugose ventrally. Propodeum rugulose-reticulate to rugose-reticulate, smooth basally.

Wings: Fore wing: Stigma 3.9 times as long as wide; basal posterior section of stigma 1.4 times apical posterior section of stigma; r-rs: 3+4/Rs: 2/Rs=1: 5.1: 1.9; r-rs 0.88 times as long as stigma width; length of vein R1 1.1 times fore wing length from apex of cell 2R1 to wing apex; 2+3/M 1.7 times as long as 2/Rs+M; 1cu-a almost interstitial. Hind wing 5.5 times as long as wide.

Hind leg: Coxa granulate-coriaceous, rugulose dorsally. Length of femur, tibia and basitarsus about 3.8, 8.0 and 8.6 times their width, respectively; tibial spurs 0.50 and 0.32 times as long as basitarsus.

Metasoma: First tergum 1.6 times as long as wide apically, costulate, interspace punctate, smooth apically, dorsal carinae absent. Second and third terga combined 1.3 times as long as wide at second metasomal suture, second tergum largely closely punctate, smooth apically; third tergum closely punctate, smooth basally and apically; second metasomal suture distinct, smooth; lateral crease of third tergum only distinct anteriorly; fourth tergum faintly coriaceous anteriorly. Ovipositor sheath 0.54 times as long as fore wing and 1.8 times as long as metafemur.

Color: Black; palpi and tegula dark brown. Antenna dark brown to blackish brown. Wings faintly brownish hyaline; stigma and veins dark brown. Legs dark brown; metacoxa black, metatibial spurs brown. Ovipositor sheath dark brown.

Length: Body 4.1 mm, antenna 4.0 mm, fore wing 3.4 mm, ovipostior sheath 1.8 mm.

Male: Similar to female.

Specimens examined: Tayuling, 1♀, 12-15.IX.1980 (KSL & CHW). Tsuifeng, 1♂, 1-3. IX.1982 (LYC & KCC).

Distribution: Europe, Mongolia, Taiwan (new record).

Host: Unknown.

Orgilus lini sp. n.

(Figs. 19, 33, 47, 61, 75, 91, 105, 119, 133, 146)

Female: Head: 1.7 times as wide as long and 1.1 times wider than mesonotum, granulate-coriaceous. Eye 2.0 times as long as temple in dorsal view, eye height 1.5 times eye length in lateral view. POL: OD: OOL=1: 1.3: 2.7. Face and clypeus combined 1.1 times as high as wide and 1.0 times as wide as eye height and 0.55 times as wide as head; convex. Tentorial index 0.58. Malar space 0.88 times basal width of mandible and 0.23 times eye height. Length of maxillary palp 1.0 times height of head. Antenna 29-segmented; first flagellomere 1.2 times as long as second; length of first, second and penultimate flagellomeres 3.3, 2.7 and 1.9 times their width, respectively.

Mesosoma: 1.4 times as long as high. Pronotal side coriaceous dorsally, crenulate medioanteriorly, granulate-coriaceous ventrally. Notauli well impressed. crenulate; mesoscutum granulate-coriaceous, scutellum coriaceous. Mesopleuron smooth to slightly coriaceous above precoxal sulcus, slightly coriaceous below precoxal sulcus; precoxal sulcus weakly crenulate. Metapleuron slightly coriaceous. Propodeum smooth.

Wings: Fore wing: Stigma 3.4 times as long as wide; basal posterior section of stigma 1.2 times apical posterior section of stigma; r-rs: 3+4/Rs: 2/Rs=1: 8.1: 2.2; r-rs 0.67 times as long as stigma width; length of vein R1 10.0 times fore wing length from apex of cell 2R1 to wing apex; 2+3/M absent; 1cu-a postfurcal. Hind wing 4.3 times as long as wide.

Hind leg: Coxa rather granulate-coriaceous. Length of femur, tibia and basitarsus about 3.9, 8.3 and 8.3 times their width, respectively; tibial spurs 0.44 and 0.34 times as long as basitarsus.

Metasoma: First tergum 1.1 times as long as wide apically, densely punctate, with some rugae laterally, dorsal carinae distinct in basal half. Second and third terga combined 0.87 times as long as wide at second metasomal suture, second tergum densely punctate; second metasomal suture deep and wide, crenulate; third tergum more or less densely punctate anteriorly, smooth posteriorly, lateral crease only distinct anteriorly. Ovipositor 0.30 times as long as fore wing and 1.1 times as long as metafemur.

Color: Blackish brown; head (except frons and vertex medially), pronotum and tegula yellowish brown. Antenna dark brown. Wings hyaline; stigma and veins dark brown. Legs yellowish brown; metatibia dark brown subbasally and apically, metatibial spurs yellowish

brown, tarsi dark brown. Ovipositor sheath missing.

Length: Body 3.5 mm, antenna 3.9 mm, fore wing 3.5 mm, ovipositor 1.1 mm.

Male: Unknown.

Specimen examined: Holotype: Sungkang 1♀, IX, 1985(KSL).

Distribution: Taiwan.

Host: Unknown.

Remarks: This species is close to *O. cretus* sp. n., but differs from it by the second and third metasomal terga combined 0.87 times as long as wide at second metasomal suture, mesosoma 1.4 times as long as high and the antenna 29-segmented.

Etymology: Name after Mr. Kwei-shui Lin, the collector of this species.

Orgilus meifengensis sp. n.

(Figs. 20, 35, 49, 63, 77, 93, 107, 121, 135, 148)

Female: Head: 1.5 times as wide as long and 1.2 times wider than mesonotum; granulate-coriaceous. Eye 2.2 times as long as temple in dorsal view, eye height 1.4 times eye length in lateral view. Frons deeply depressed medially. POL: OD: OOL=1: 1.0: 2.3. Face and clypeus combined 1.0 times as high as wide and 1.2 times as wide as eye height and 0.61 times as wide as head; face convex, clypeus strongly convex. Tentorial index 0.77. Malar space 1.0 times basal width of mandible and 0.26 times eye height. Length of maxillary palp 1.0 times height of head. Antenna beyond 31 segment broken; first flagellomere 1.2 times as long as second; length of first and second flagellomeres 3.7 and 3.1 times their width, respectively.

Mesosoma: 1.7 times as long as high. Pronotal side coriaceous dorsally, crenulate medioanteriorly, granulate-coriaceous ventrally. Notauli well impressed, crenulate, mesonotum granulate-coriaceous. Mesopleuron largely coriaceous, except largely smooth anteroventrally above precoxal sulcus; precoxal sulcus weakly crenulate. Matapleuron coriaceous. Propodeum largely smooth, rugulose medially.

Wings: Fore wing: Stigma 3.7 times as long as wide, basal posterior section of stigma 1.6 times apical posterior section of stigma; r-rs: 3+4/Rs : 2/Rs =1: 8.6: 2.4; r-rs 0.65 times as long as stigma width; length of vein R1 9.2 times fore wing length from apex of cell 2R1 to wing apex; 2+3/M absent; 1cu-a weakly postfurcal. Hind wing 5.5 times as long as wide.

Hind leg: Coxa granulate-coriaceous. Length of femur, tibia and basitarsus about 4.2, 8.0 and 8.3 times their width, respectively; tibial spurs 0.48 and 0.37 times as long as basitarsus.

Metasoma: First tergum 1.2 times as long as wide apically; largely punctate-reticulate, with some rugae, largely glabrous between dorsal carinae; dorsal carinae distinct in basal half. Second and third terga combined 1.1 times as long as wide at second metasomal suture; second tergum punctate-reticulate; second metasomal suture deep and wide, crenulate; third tergum largely punctate-reticulate, smooth spically, with complete sharp lateral crease; fourth tergum densely punctulate. Ovipositor sheath 0.32 times as long as fore wing and 1.3 times as long as metafemur.

Color: Brownish yellow, stemmaticum black, three lobes of mesoscutum more or less dark brown, metanotum, apex propodeum, anterior first metasomal tergum and basal second metasomal tergum dark brown. Antenna brownish yellow to dark brown. Wings hyaline; stigma and veins dark brown. Legs brownish yellow; subbasal and apical metatibia, and metatarsus (except basal basitarsomere yellow) dark brown to blackish brown, metatibial spurs yellow. Ovipositor sheath dark brown.

Length: Body 4.0 mm, antenna more than 4.5 mm, fore wing 3.8 mm, ovipositor sheath 1.2 mm.

Male: Unknown.

Specimen examined: Holotype: Meifeng, 1♀, 24-26.VI.1981 (KSL & WST).

Distribution: Taiwan.

Host: Unknown.

Remarks: This species is close to *O. caritus* sp. n., but differs from it by the first metasomal tergum largely glabrous between dorsal carinae, basal posterior section of stigma 1.6 times apical posterior section of stigma and the fore wing vein r-rs: 3+4/Rs: 2/Rs about 1: 8.6: 2.4.

Etymology: Named after Meifeng, the type locality.

Orgilus parapappianus sp. n.

(Figs. 11, 25, 37, 53, 65, 79, 95, 108, 123, 137)

Female: Head: 1.5-1.6 times as wide as long and 1.0-1.1 times wider than mesonotum. Eye 1.5 times as long as temple in dorsal view, eye height 1.8-1.9 times eye length in lateral view. Temple densely punctulate. Frons largely glabrous medially, densely punctulate laterally. POL: OD: OOL=1: 1.1-1.2: 2.3-2.5. Vertex densely punctulate. Face and clypeus combined 1.4-1.5 times as high as wide and 0.82-0.89 times as wide as eye height and 0.52 times as wide as head; face convex, densely punctulate; clypeus strongly convex, sparsely punctulate. Tentorial index 0.36-0.38. Malar space 2.3-2.4 times basal width of mandible and 0.44-0.45 times eye height. Length of maxillary palp 0.6 times height of head. Antenna 28-segmented; first flagellomere 1.0-1.1 times as long as second; length of first, second and penultimate flagellomeres 2.7-2.8, 2.6-2.8 and 1.2-1.3 times their width, respectively.

Mesosoma: 1.4-1.5 times as long as high. Pronotal side densely punctulate dorsally, rugose-reticulate ventrally. Notauli well impressed, crenulate; mesonotum densely punctate, Mesopleuron rather sparsely punctate above precoxal sulcus, densely punctulate below precoxal sulcus; precoxal sulcus crenulate. Metapleuron rather densely punctulate. Propodeum rather densely punctulate to punctate, rugose-reticulate medially and around spiracle.

Wings: Fore wing: Stigma 3.3 times as long as wide; basal posterior section of stigma 1.2 times apical posterior section of stigma; r-rs: 3+4/Rs: 2/Rs=1: 5.0-5.4: 1.4-1.5; r-rs almost as long as stigma width; length of vein R1 8.8-9.5 times fore wing length from apex of cell 2R1 to wing apex; 2+3/M 1.2 times as long as 2/Rs+M; lcu-a postfurcal. Hind wing 4.0 times as long as wide.

Hind leg: Coxa densely punctate. Length of femur, tibia and basitarsus about 4.0-4.5, 6.1-6.5 and 7.7-8.3 times their width, respectively; tibial spurs 0.52-0.57 and 0.34-0.37 times as long as basitarsus.

Metasoma: First tergum 0.89 times as long as wide apically, rugose-reticulate, dorsal carinae distinct in basal half. Second and third terga combined 1.1 times as long as wide at second metasomal suture; second tergum rugose-reticulate, second metasomal suture deep and wide, crenulate; third tergum largely rugose-reticulate, smooth basally and apically, with complete sharp lateral crease. Ovipositor sheath 0.50-0.57 times as long as fore wing and 1.6-1.8 times as long as metafemur.

Color: Black; mandible and tegula dark brown, palpi yellowish brown. Antenna black. Wings hyaline; stigma and veins dark brown. Legs yellowish brown; apical metafemur, and metatarsus blackish brown, basal 0.5 of metatibia more or less lighter. Ovipositor sheath black.

Length: Body 3.8 mm, antenna 3.8-3.9 mm, fore wing 3.4-3.6 mm, ovipositor sheath 1.8-1.9 mm.

Male: Similar to female. Third metasomal tergum punctate medially.

Specimens examined: Holotype: ♀, Tungpu, 18-21.X.1982 (KCC & SCL). Paratypes: Tungpu, 1♂, 5-8.X.1981 (TL & WST); 1♀, 18-23.XI.1981 (TL & WST);

Distribution: Taiwan.

Host: Unknown.

Remarks: This species is close to *O. pappianus* Taeger[15], but differs from it by the shape of head in lateral view.

Etymology: The specific name of this new species refers to it is close to *O. pappianus* Taeger.

Orgilus planus sp. n.
(Figs. 12, 24, 40, 50, 68, 82, 113, 126, 139, 150)

Female: Head: 1.6 times as wide as long and 1.2 times wider than mesonotum. Eye 1.2 times as long as temple in dorsal view, eye height 1.7 times eye length in lateral view. Temple densely punctulate. Frons largely smooth medially, densely punctulate laterally. POL: OD: OOL=1: 0.50: 1.2. Vertex densely punctulate. Face and clypeus combined 1.1 times as high as wide and 1.1 times as wide as eye height and 0.59 times as wide as head; strongly convex, densely punctate, with some rugae near toruli. Tentorial index 0.62. Malar space 1.6 times basal width of mandible and 0.47 times eye height. Length of maxillary palp 0.9 times height of head. Antenna 30-segmented; first flagellomere 1.3 times as long as second; length of first, second and penultimate flagellomeres 2.6, 2.1 and 1.0 times their width, respectively.

Mesosoma: 1.4 times as long as high. Pronotal side rather densely punctulate dorsally; rugose medially, rugulose ventrally. Notauli well impressed, crenulate; mesoscutum densely punctate, scutellum rather densely punctulate. Mesopleuron rather densely punctulate above precoxal sulcus, densely punctulate below precoxal sulcus; precoxal sulcus crenulate. Metapleuron rather densely punctulate, rugose ventrally. Propodeum largely rugose-reticu-

late, smooth basally.

Wings: Fore wing: Stigma 3.2 times as long as wide; basal posterior section of stigma 1.4 times apical posterior section of stigma; r-rs: 3+4/Rs: 2/Rs=1: 3.8: 1.4; r-rs almost as long as stigma width; length of vein R1 2.0 times fore wing length from apex of cell 2R1 to wing apex; 2+3/M 1.1 times as long as 2/Rs+M; lcu-a postfurcal. Hind wing 4.0 times as long as wide.

Hind leg: Coxa rugose dorsally. Length of femur, tibia and basitarsus about 4.6, 8.3 and 7.1 times their width, respectively; tibial spurs 0.56 and 0.38 times as long as basitarsus.

Metasoma: First tergum 1.2 times as long as wide apically, largely smooth, with some rugulae and punctures, dorsal carinae absent. Second and third terga combined 1.2 times as long as wide at second metasomal suture, second and third terga smooth; second metasomal suture weak, smooth; lateral crease of third tergum only distinct anteriorly. Ovipositor sheath 0.42 times as long as fore wing and 1.2 times as long as metafemur.

Color: Black; palpi dark brown. Antenna blackish brown. Wings fainthy brownish hyaline; stigma and veins dark brown. Legs dark brown to blackish brown, metatibial spurs brown. Oviposito sheath dark brown.

Length: Body 3.9 mm, antenna 3.5 mm, fore wing 3.2 mm, ovipositor sheath 1.4 mm.

Male: Similar to female.

Specimens examined: Holotype: ♀, Sungkang, X.1984 (KSL & KCC). Paratype: Tayuling, 1♂, 12-15.IX.1980 (KSL & CHW).

Distribution: Taiwan.

Host: Unknown.

Remarks: This species differs from the other Taiwanese *Orgilus* species by the following combination of characters: face and clypeus combined about 1.1 times as high as wide, vein 3+4/Rs of fore wing ending well before tip of wing, vien 2+3/M of fore wing present, second metasomal tergum smooth, lateral crease of third metasomal tergum only distinct anteriorly and ovipositor sheath about 0.4 times as long as fore wing length.

Etymology: *Planus* means smooth in Latin, refers to its second and third metasomal terga smooth.

Orgilus rarus sp. n.

(Figs. 21, 30, 44, 57, 72, 85, 87, 102, 115, 130, 143)

Female: Head: 1.6-1.7 times as wide as long and 1.1 times wider than mesonotum. Eye 2.2-2.3 times as long as temple in dorsal view, eye height 1.6 times eye length in lateral view. Temple and vertex rather densely punctulate. Frons glabrous medially, rather densely punctulate laterodorsally, granulate-coriaceous lateroventrally. POL: OD: OOL=1: 0.86: 1.7-1.9. Face and clypeus combined 1.1 times as high as wide and 1.0 times as wide as eye height and 0.54-0.55 times as wide as head, slightly convex; face densely punctate; clypeus sparsely punctulate. Tentorial index 0.58-0.60. Malar space 1.1 times basal width of mandible and 0.29-0.31 times eye height. Length of maxillary palp 1.1 times height of head. Antenna 31-32-segmented; first flagellomere 1.0 times as long as second; length of first,

second and penultimate flagellomeres 3.2-3.3, 3.2-3.3 and 1.5-1.6 times their width, respectively.

Mesosoma: 2.0 times as long as high. Pronotal side largely glabrous dorsally, crenulate medially, densely punctate to coriaceous ventrally, densely punctate posteriorly. Notauli well impressed, crenulate; mesoscutum densely punctate, scutellum rather densely punctulate. Mesopleuron rather densely punctulate above precoxal sulcus, densely punctulate below precoxal sulcus; precoxal sulcus crenulate. Metapleuron largely densely punctate, rugose along ventral borders. Propodeum rather densely punctate laterally; densely punctate wigh some rugae medially.

Wings: Fore wing: Stigma 3.9 times as long as wide; basal posterior section of stigma 1.2-1.3 times apical posterior section of stigma; r-rs: 3+4/Rs: 2/Rs=1: 6.5-7.4: 1.6-1.8; r-rs 0.91 times as long as stigma width; length of vein R1 15.7-16.3 times fore wing length from apex of cell 2R1 to wing apex; 2+3/M 0.7 times as long as 2/Rs+M; lcu-a postfurcal. Hind wing 4.3 times as long as wide.

Hind leg: Coxa weakly rugulose dorsally. Length of femur, tibia and basitarsus 4.2-4.5, 8.6-9.5 and 9.3-10.0 times their width, respectively; tibial spurs 0.40-0.41 and 0.24-0.26 times as long as basitarsus.

Metasoma: First tergum 1.3-1.5 times as long as wide apically, costate; dorsal carinae distinct in basal half. Second and third terga combined 1.1-1.2 times as long as wide at second metasomal suture; second tergum costate; second metasomal suture deep and wide, weakly crenulate; third tergum more or less costate anteriorly, rest smooth; lateral crease of third tergum only distinct anteriorly. Ovipositor sheath 1.2-1.3 times as long as fore wing and 4.6-4.8 times as long as metafemur.

Color: Black; face, clypeus and gena yellowish brown, palpi and tegula yellow to brownish yellow, second metasomal tergum dark brown laterally, metasomal terga beyond third tergum more or less yellowish brown to dark brown. Antenna dark brown. Wings hyaline; stigma and veins dark brown. Legs brownish yellow to brownish yellow; metacoxa black basally, lighter towards apex; metatibia and tarsi dark brown, metatibia spurs yellow. Ovipostior sheath dark brown.

Length: Body 4.5-5.0 mm., antenna 4.5-5.0 mm, fore wing 4.0-4.5 mm, ovipositor sheath 4.8-5.7mm.

Male: Similar to female.

Specimens examined: Holotype: ♀, Sungkang, IX.1984 (KSL & KCC). Paratypes: Lushan, 2♀, 27-31.V.1980 (KSL & LYC). Meifeng, 5♀,1♂, 5-9.X.1980 (CCC & CCCh); 1♀, 24-26.VI.1981 (KSL & WST); 3♀,VIII, 7♀, IX. 7♀,X. 1984 (KSL & KCC); 13♀, X.1985 (KSL). Sungkang, 2♀, 15-17.VIII.1984 (KCC); 2♀, 13-15.IX.1984 (KSL & SCL); 1♀, IX. 1984 (KSL & KCC); 30♀, X, 9♀, XI.1984 (KSL & KCC); 8♀, IX, 85♀, X, 2♀, XI.1985 (KSL). Tayuling, 2♀, 10-15.IX.1980 (KSL & CHW). Tsuifeng, 1♀, 1-3.VIII.1981 (TL & WST); 1♀, 27.VIII.1981 (LYC & SCL); 1♀, 15-16.VIII.1984 (KCC); 1♀, 12-14.IX.1984 (KSL & SCL); 3♀, VIII, 8♀, IX, 17♀, X, 3♀, XI.1984 (KSL & KCC); 9♀, IX, 5♀, X.1985 (KSL). Wushe, 3♀, 6-11.V.1981 (KSL & SCL); 1♀, 30.VIII-2.IX.1982 (LYC & KCC); 1♀, 7.V.1984 (KCC &

CCP); 1♀, 4.VIII.1984 (KSL);1♀, 11-15.IX.1984 (KSL).

Distribution: Taiwan.

Host: Unknown.

Remarks: This species differs from the other Taiwanese *Orgilus* species by the following combination of characters: antenna with 31-32 segments, vertex punctulate, face and clypeus combined about 1.1 times as high as wide, third metasomal tergum without complete sharp lateral crease and ovipositor sheath about 4.6-4.8 times as long as fore wing length.

Etymology: *Rarus* mean scarce in Latin, refers to the male of this species is only one speciment in this study.

Orgilus taiwanensis sp. n.

(Figs. 13, 26, 41, 55, 69, 83, 99, 114, 127, 140, 153)

Female: Head: 1.5 times as wide as long and 1.2-1.3 times wider than mesonotum. Eye 1.4-1.5 times as long as temple in dorsal view, eye height 1.6 times eye length in lateral view. Temple coriaceous; frons (except medially rather smooth) and vertex granulate-coriaceous. POL: OD: OOL=1: 0.56-0.63: 1.3. Face and clypeus combined 1.0 times as high as wide and 1.1 times as wide as eye height and 0.60 times as wide as head; face convex, largely densely punctate, granulate-coriaceous dorsally and laterally, clypeus strongly convex, rather densely punctate. Tentorial index 0.46-0.47. Malar space 1.3-1.4 times basal width of mandible and 0.37-0.39 times eye height; granulate-coriaceous. Length of maxillary palp 1.0 times height of head. Antenna 29-segmented; first flagellomere 1.2-1.3 times as long as second; length of first, second and penultimate flagellomeres 2.7-3.0, 2.1-2.6 and 1.3 times their width, respectively.

Mesosoma: 1.5-1.6 times as long as high. Pronotal side largely granulate-coriaceous; medially rugose. Notauli well impressed, crenulate; mesoscutum densely punctate, scutellum rather sparsely punctulate, Mesopleuron rather sparsely punctulate above precoxal sulcus, largely coriaceous below precoxal sulcus; precoxal sulcus crenulate. Metapleuron smooth to coriaceous, rugose ventrally. Propodeum rugulose-reticulate to rugose-reticulate.

Wings: Fore wing: Stigma 3.8 times as long as wide; basal posterior section of stigma 1.1-1.3 times apical posterior section of stigma; r-rs: 3+4/Rs: 2/Rs=1: 4.9-5.2: 1.8-1.9; r-rs 0.88 times as long as stigma width; length of vein R1 1.4 times fore wing length from apex of cell 2R1 to wing apex; 2+3/M 1.6 times as long as 2/Rs+M; lcu-a postfurcal. Hind wing 4.8-4.9 times as long as wide.

Hind leg: Coxa coriaceous, rugulose dorsally. Length of femur, tibia and basitarsus 4.4-4.7, 7.5-7.6 and 8.2-8.4 times their width, respectively; tibial spurs 0.56-0.57 and 0.42-0.43 times as long as basitarsus.

Metasoma: First tergum 1.4-1.5 times as long as wide apically; weakly punctate medially, rather costulate laterally; smooth basally and apically; dorsal carinae absent. Second and third terga combined 1.3 times as long as wide at second metasomal suture, second tergum densely punctate anteriorly, smooth posteriorly; second metasomal suture

weak, smooth; third tergum smooth, lateral crease only distinct anteriorly. Ovipositor sheath 0.72-0.73 times as long as fore wing and 2.1-2.2 times as long as metafemur.

Color: Black; palpi and tegula dark brown. Antenna dark brown, scape and pedical black. Wings faintly brownish hyaline; stigma and veins dark brown. Legs largely dark brown to blackish brown; procoxa and mesocoxa yellowish brown, metatibial spurs brownish yellow to brown. Ovipositor sheath dark brown.

Length: Body 2.9-3.5 mm, antenna 3.0 mm, fore wing 2.7-3.0 mm, ovipositor sheath 2.0-2.1 mm.

Male: Similar to female. Antenna 30-segmented.

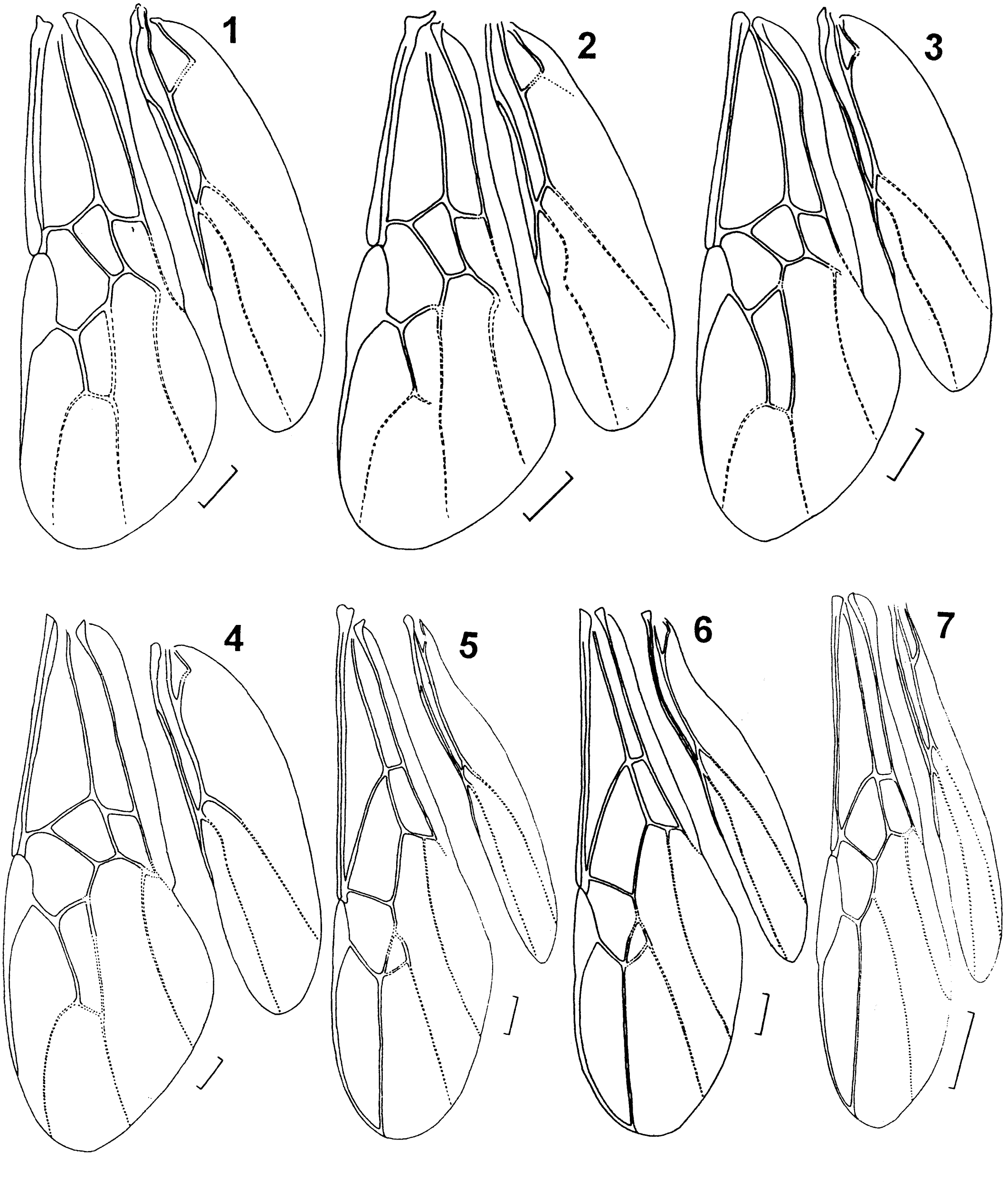
Specimens examined: Holotype: ♀, Tungpu, 25-29.IX.1980 (LYC & TL). Paratypes: Tungpu, 1♂, 25-29.IX.1980 (LYC & TL). Wuling, 1♀, 27-29.VI.1979 (KSL & LYC).

Distribution: Taiwan.

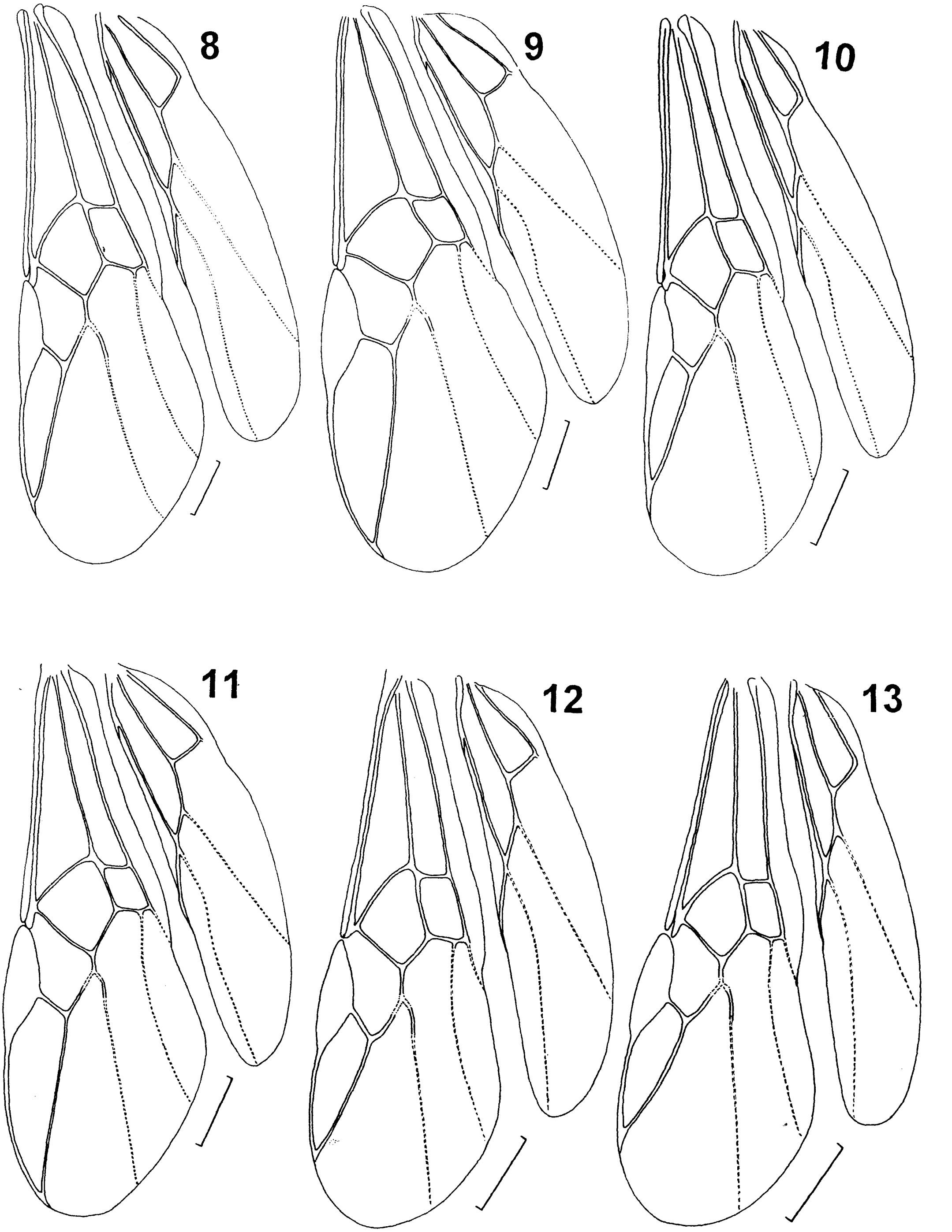
Host: Unknown.

Remarks: This species differs from the other Taiwanese *Orgilus* species by the following combination of characters: face and clypeus combined about 1.0 times as high as wide, vein 3+4/Rs of fore wing ending well before tip of wing, vein 2+3/M of fore wing present, subequal to 2/Rs+M, second metasomal tergum densely punctate anteriorly, lateral crease of third metasomal tergum only distinct anteriorly and ovipositor sheath about 0.7 times as long as fore wing length.

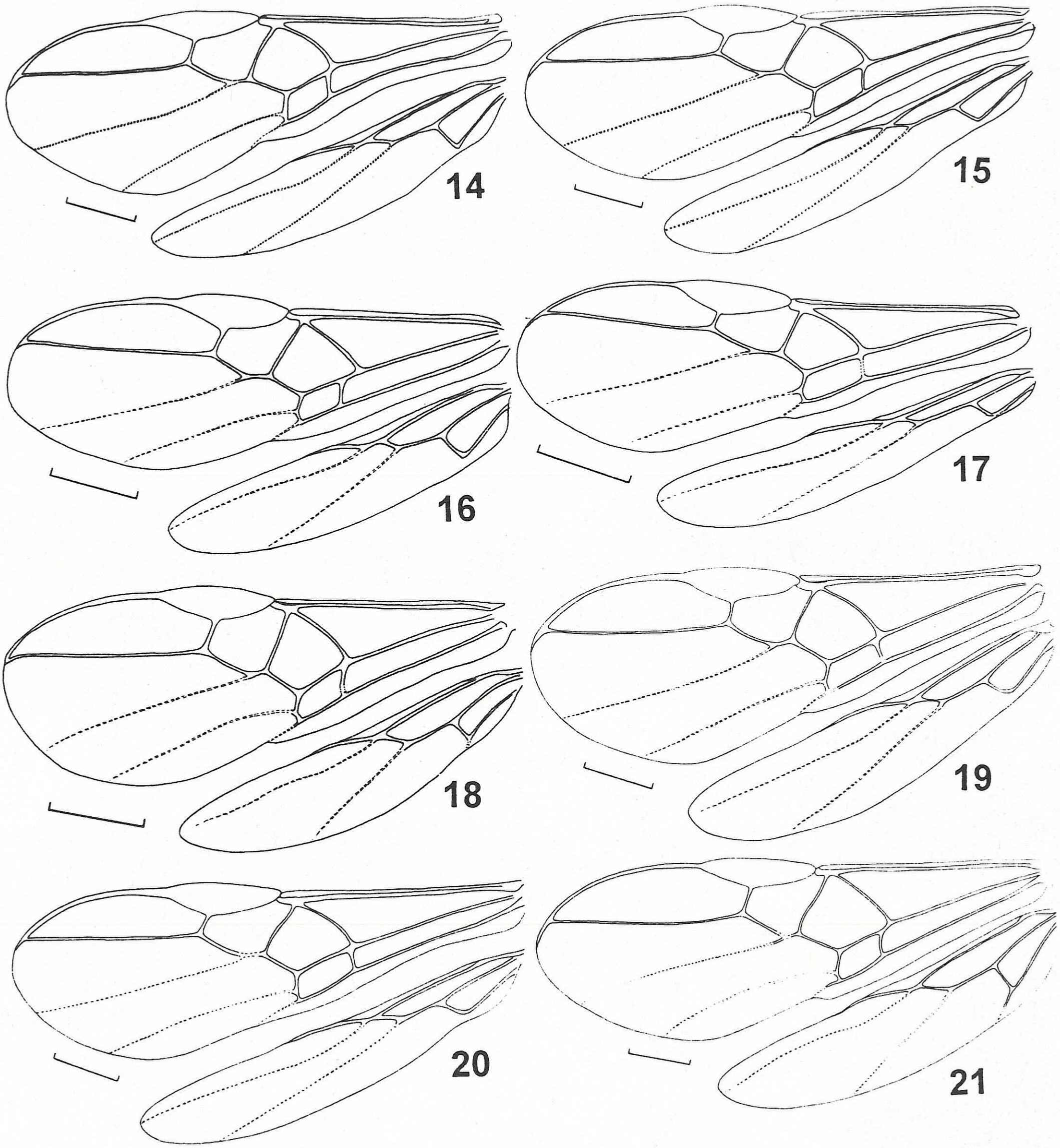
Etymology: Named after Taiwan.



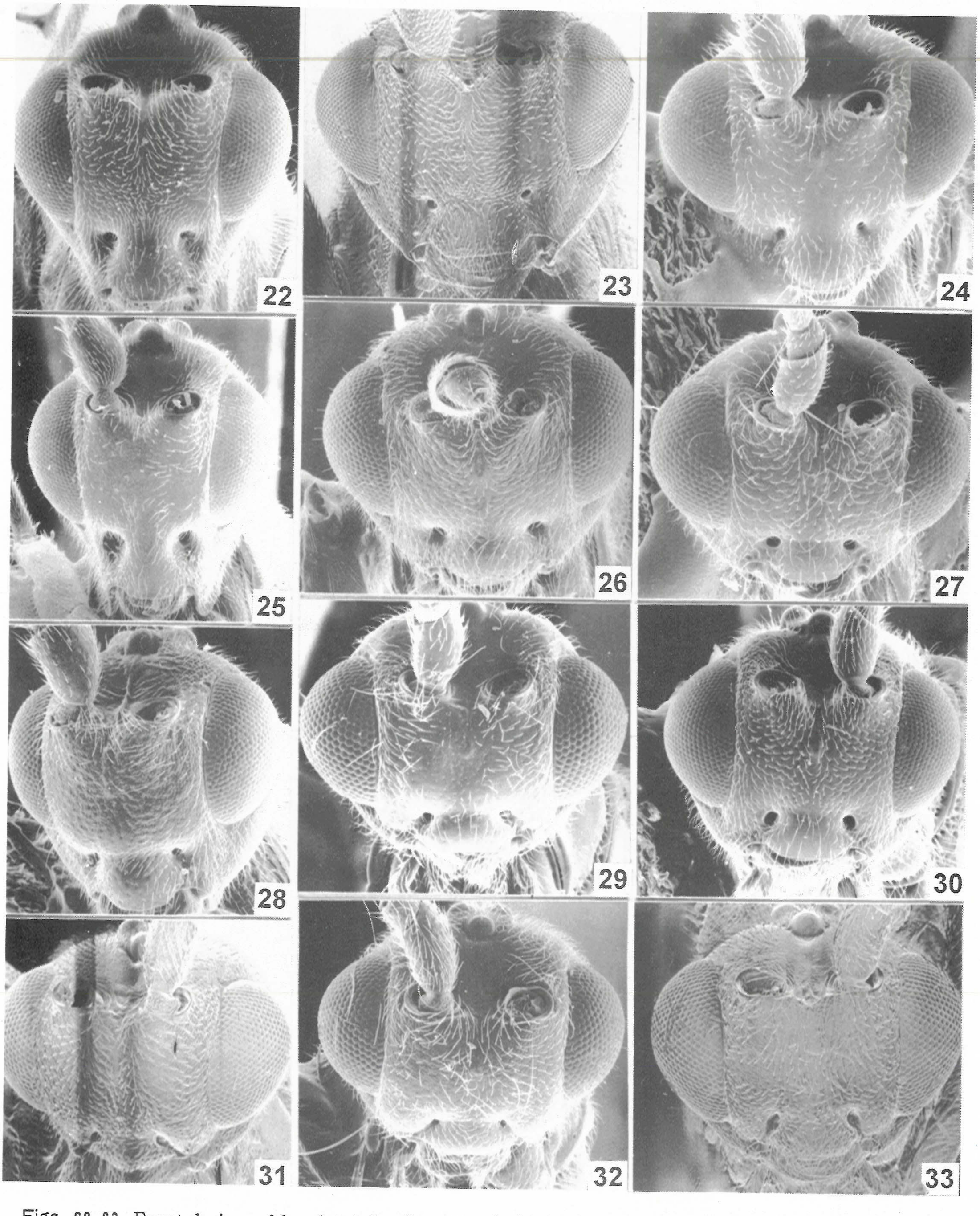
Figs. 1–7. Wings ♀ : 1, *Cardiochiles laevifossa* Enderlein; 2, *C. szepligeti* Enderlein; 3, *Hartemita latipes* Cameron; 4, *H. townesi* Dangerfield & Austin; 5, *Stantonia issikii* Watanabe; 6, *S. ruficornis* Enderlein; 7, *Orgilonia chuchiensis* sp. n. (Scale: 0.5 mm).



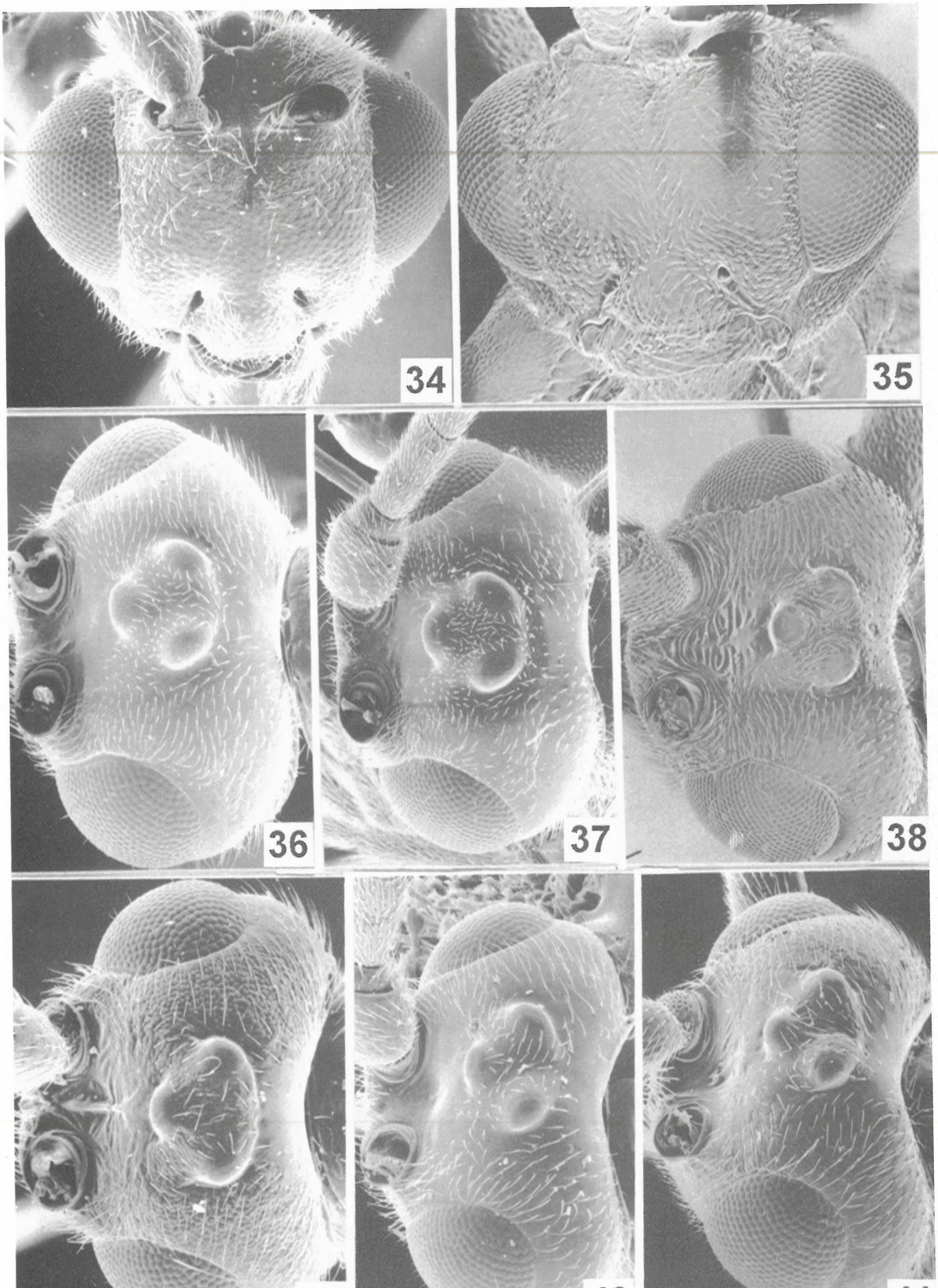
Figs. 8-13. Wings of *Orgilus* spp. ♀ : 8, *amplissimus* sp. n.; 9, *caballus* sp. n.; 10, *ischnus* Marshall; 11, *parapappianus* sp. n.; 12, *planus* sp. n.; 13, *taiwanensis* sp. n. (Scale: 0.5 mm).



Figs. 14–21. Wings of *Orgilus* spp. ♀ : 14, *caritus* sp. n.; 15, *cretus* sp. n.; 16, *cunctus* sp. n.; 17, *galbinus* sp. n.; 18, *improcerus* sp. n.; 19, *lini* sp. n.; 20, *meifengensis* sp. n.; 21, *rarus* sp. n. (Scale: 0.5 mm).

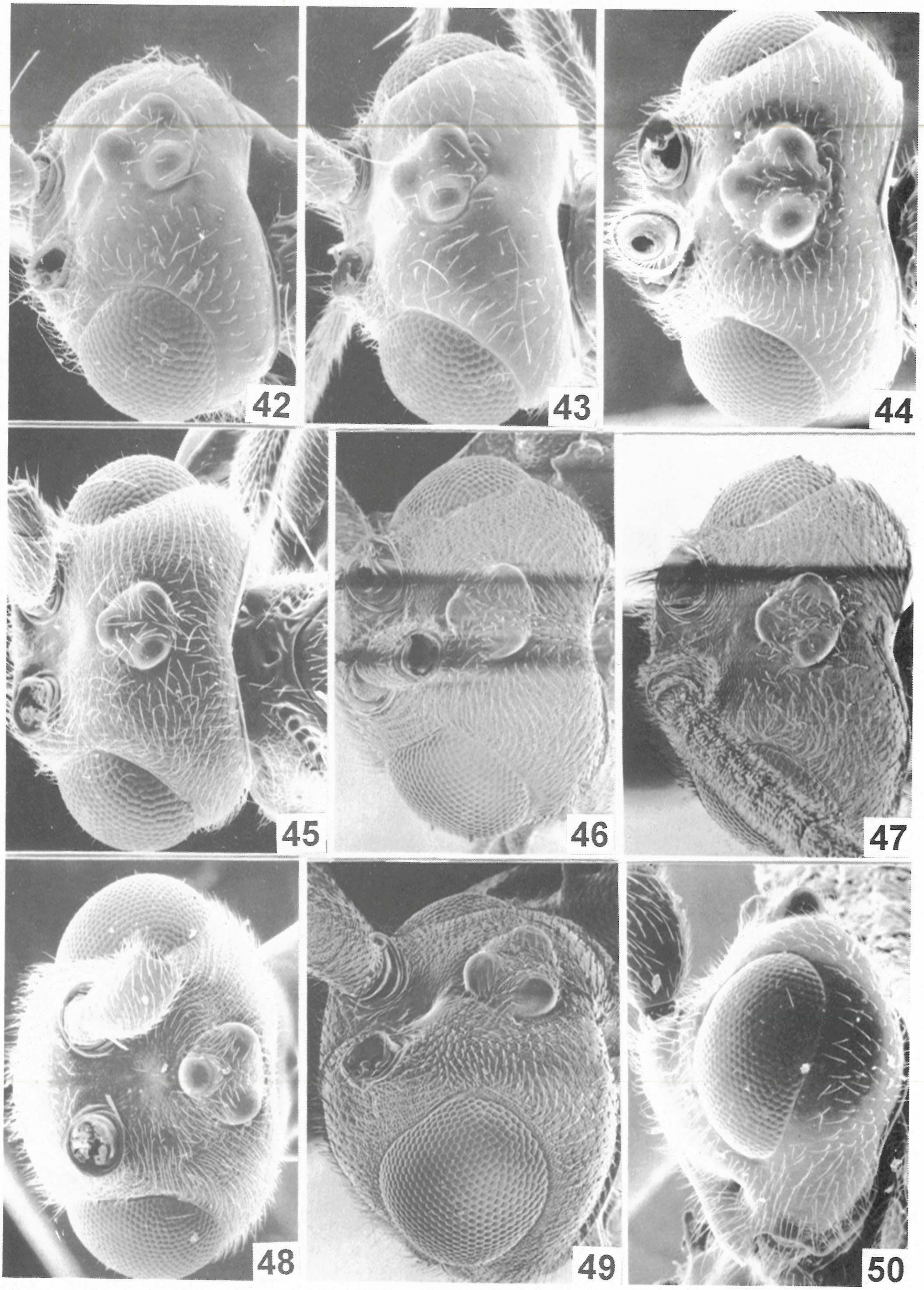


Figs. 22-33. Frontal view of heads of *Orgilus* spp. ♀ (except 24, 28♂): 22, *caballus* sp. n.; 23, *amplissimus* sp. n.; 24, *planus* sp. n.; 25, *parapappianus* sp. n.; 26, *taiwanensis* sp. n.; 27, *cunctus* sp. n.; 28, *ischnus* Marshall; 29, *improcerus* sp. n.; 30, *rarus* sp. n.; 31, *cretus* sp. n.; 32, *galbinus* sp. n.; 33, *lini* sp. n.



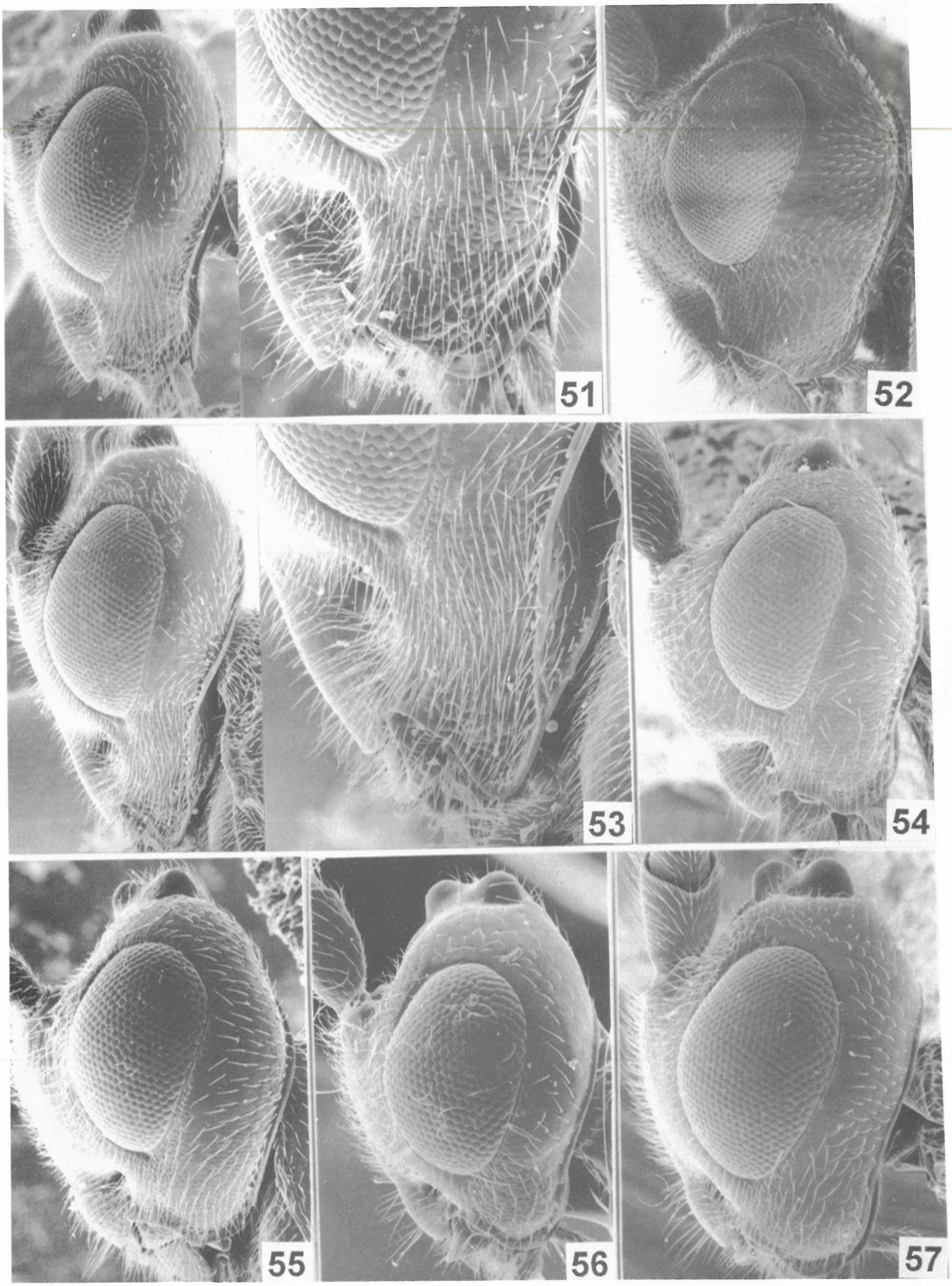
Figs. 34–35. Frontal view of heads of *Orgilus* spp. ♀ : 34, *caritus* sp. n.; 35, *meifengensis* sp. n.

Figs. 36–41. Dorsal view of heads of *Orgilus* spp. ♀ (except 39, 40 ♂): 36, *caballus* sp. n.; 37, *parapappianus* sp. n.; 38, *amplissimus* sp. n.; 39, *ischnus* Marshall; 40, *planus* sp. n.; 41, *taiwanensis* sp. n.

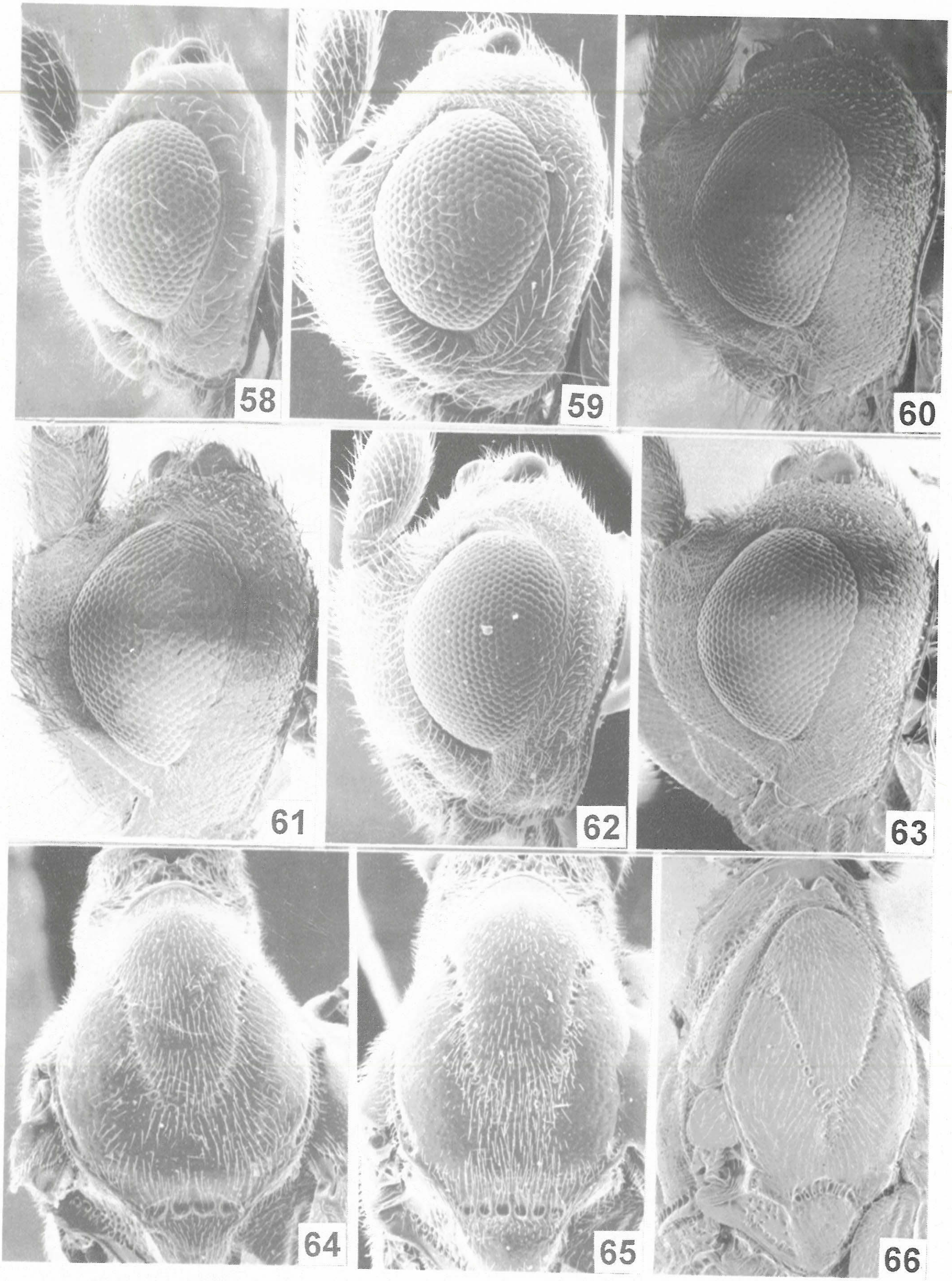


Figs. 42–49. Dorsal view of heads of *Orgilus* spp. ♀ : 42, *cunctus* sp. n.; 43, *improcerus* sp. n.; 44, *rarus* sp. n.; 45, *galbinus* sp. n.; 46, *cretus* sp. n.; 47, *lini* sp. n.; 48, *caritus* sp. n.; 49, *meifengensis* sp. n.

Figs. 50. Lateral view of head of *Orgilus planus* sp. n. ♂.

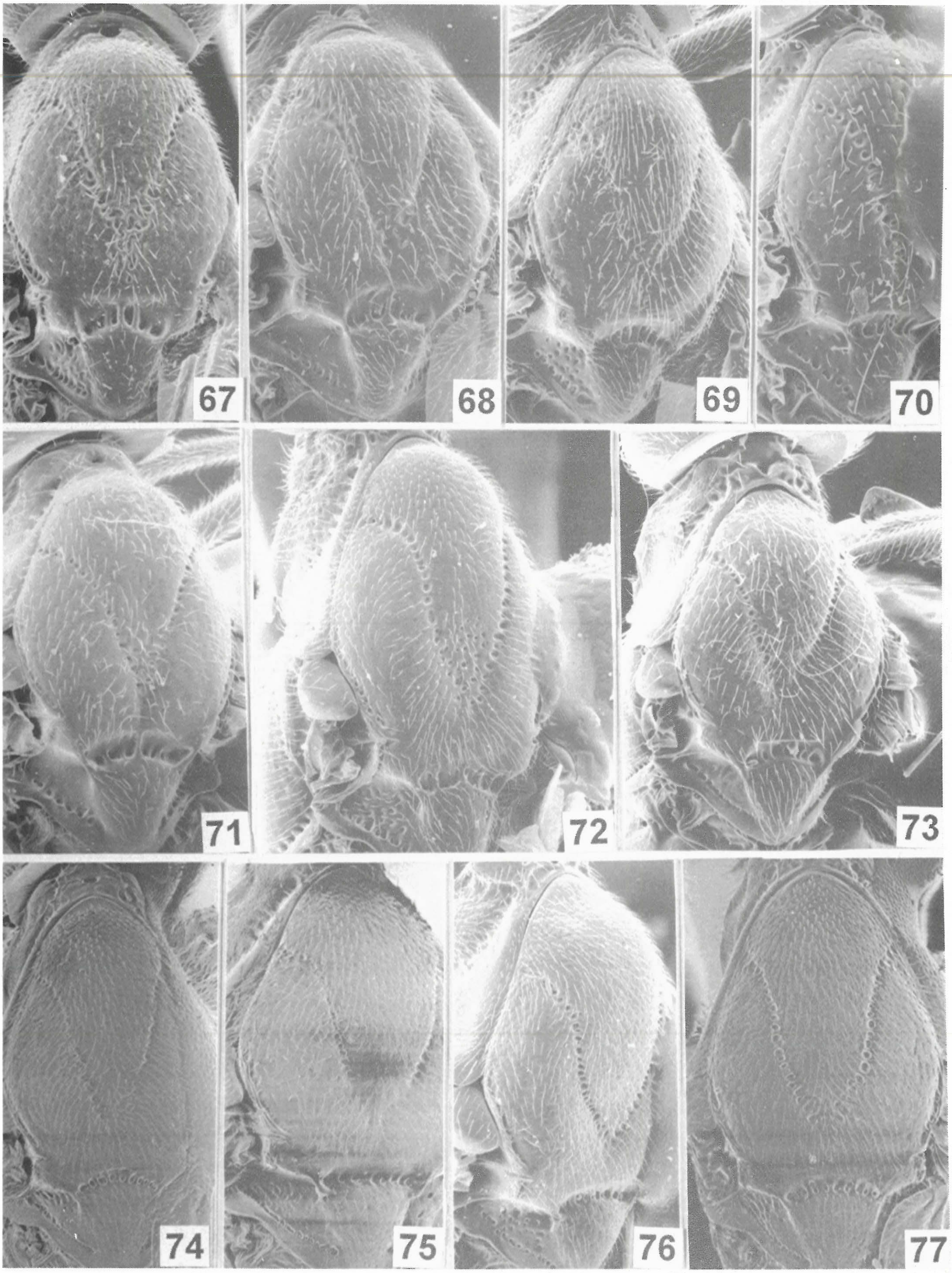


Figs. 51-57. Lateral view of heads of *Orgilus* spp. ♀ (except 54♂): 51, *caballus* sp. n.; 52, *amplissimus* sp. n.; 53, *parapappianus* sp. n.; 54, *ischnus* Marshall; 55, *taiwanensis* sp. n.; 56, *cunctus* sp. n.; 57, *rarus* sp. n.

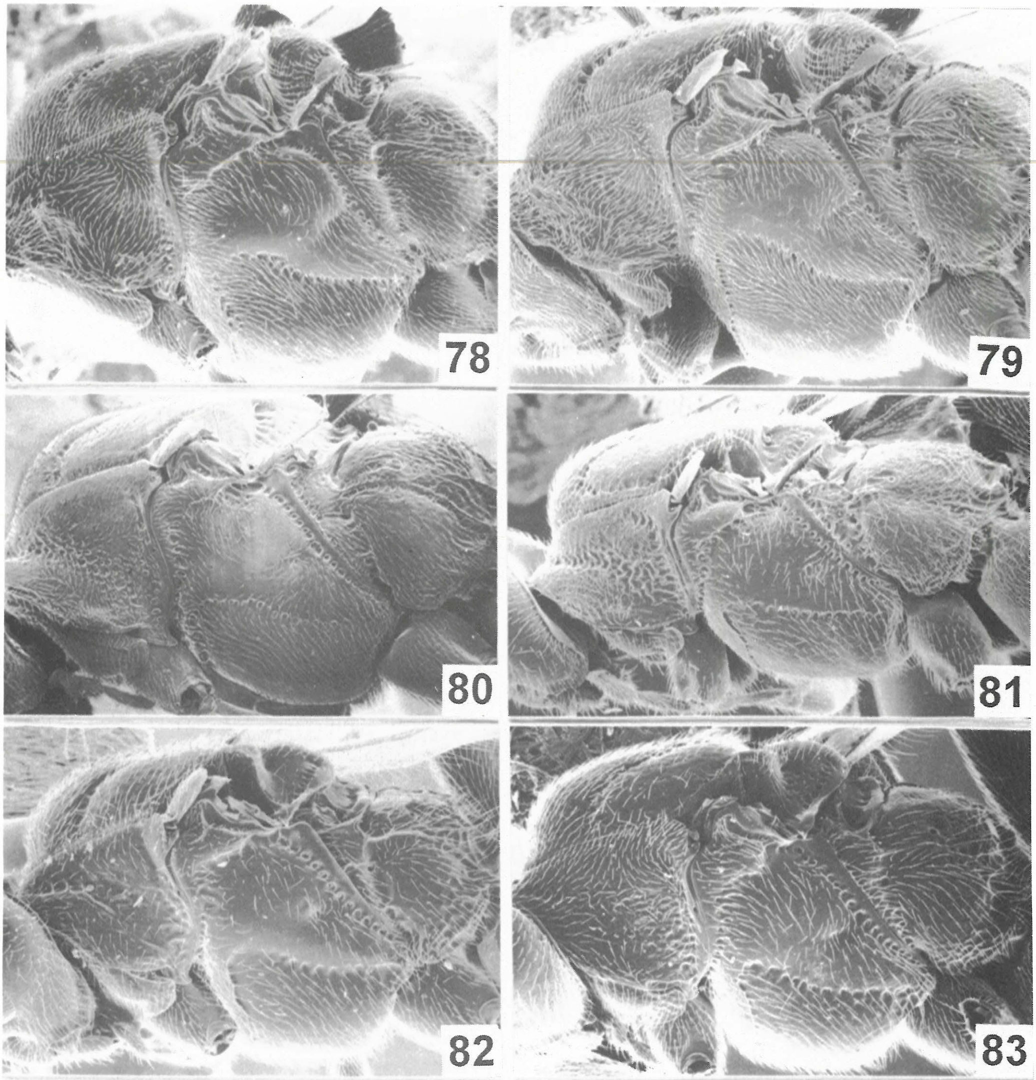


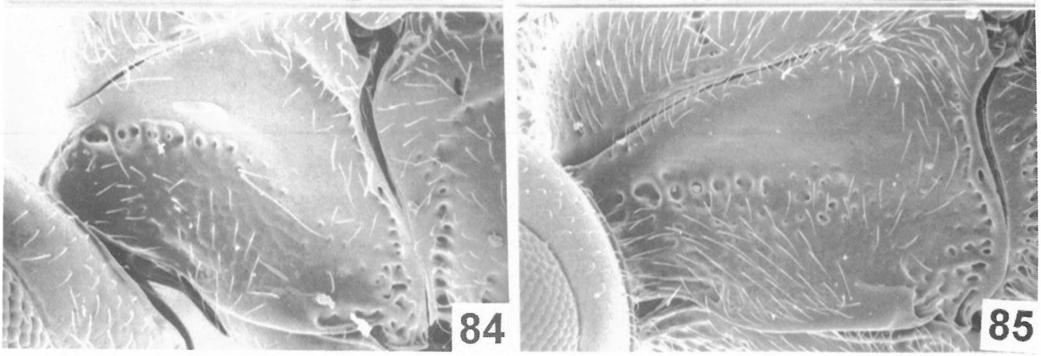
Figs. 58–63. Lateral view of heads of *Orgilus* spp. ♀ : 58, *improcerus* sp. n.; 59, *galbinus* sp. n.; 60, *cretus* sp. n.; 61, *lini* sp. n.; 62, *caritus* sp. n.; 63. *meifengensis* sp. n.

Figs. 64–66. Dorsal view of mesonota of *Orgilus* spp. ♀ : 64, *caballus* sp. n.; 65, *parapappianus* sp. n.; 66, *amplissimus* sp. n.



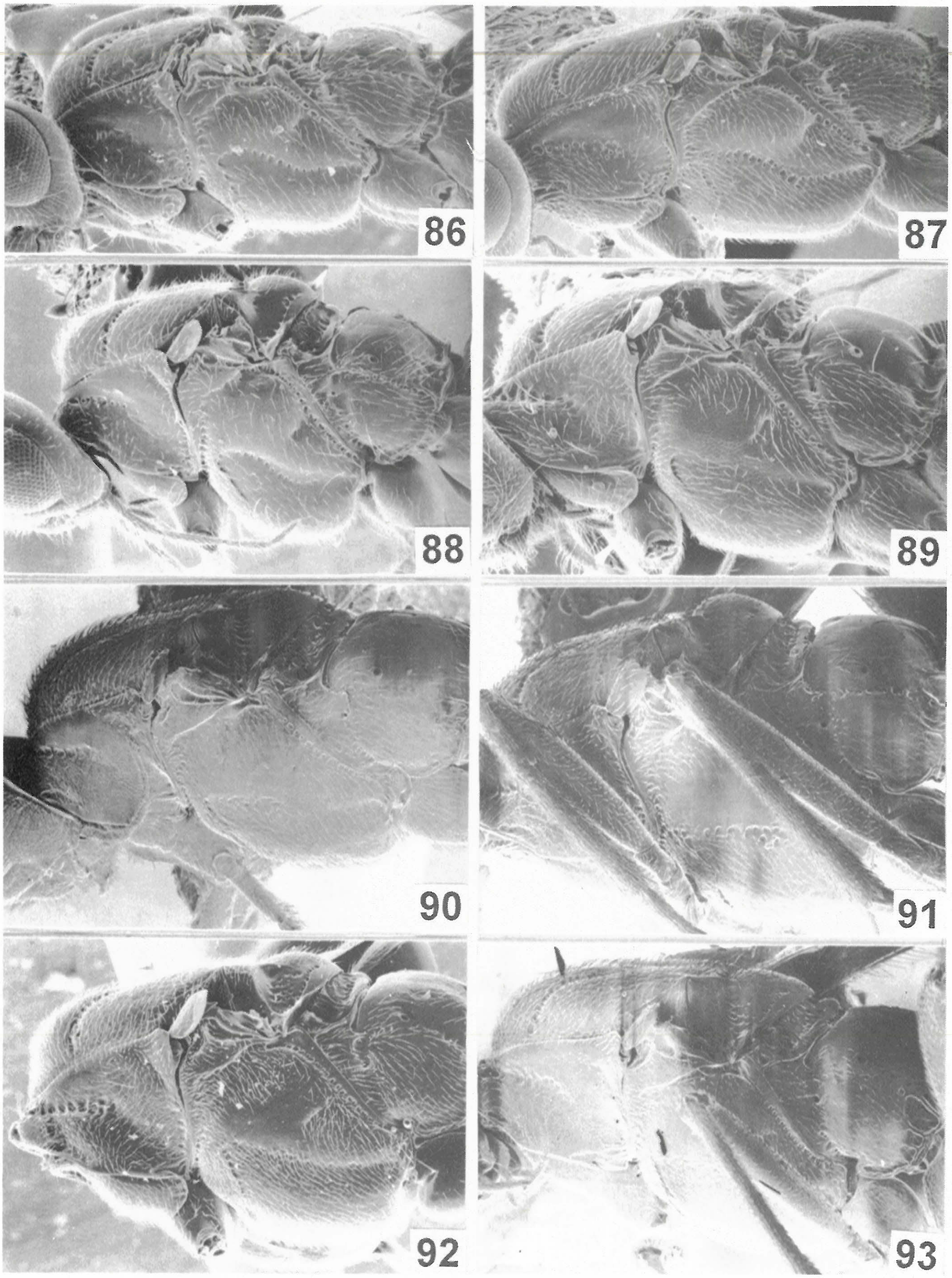
Figs. 67–77. Dorsal view of mesonota of *Orgilus* spp. ♀ (except 67, 68♂): 67, *ischnus* Marshall; 68, *planus* sp. n.; 69, *taiwanensis* sp. n.; 70, *cunctus* sp. n.; 71, *improcerus* sp. n.; 72, *rarus* sp. n.; 73, *galbinus* sp. n.; 74, *cretus* sp. n.; 75, *lini* sp. n.; 76, *caritus* sp. n.; 77, *meifengensis* sp. n.



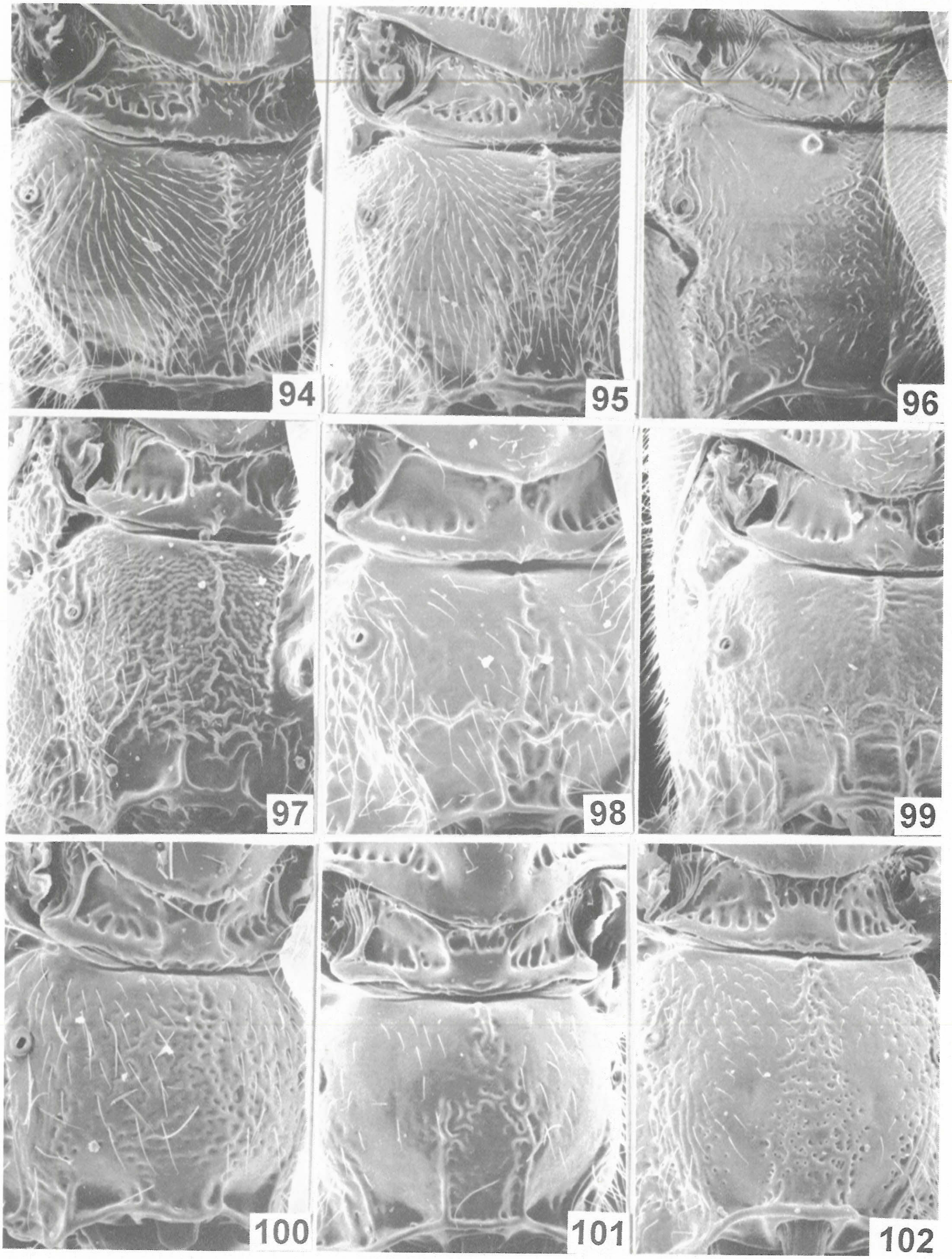


Figs. 78–83. Lateral view of mesosomata of *Orgilus* spp. ♀ (except 81, 82♂): 78, *caballus* sp. n.; 79, *parapappianus* sp. n.; 80, *amplissimus* sp. n.; 81, *ischnus* Marshall; 82, *planus* sp. n.; 83, *taiwanensis* sp. n.

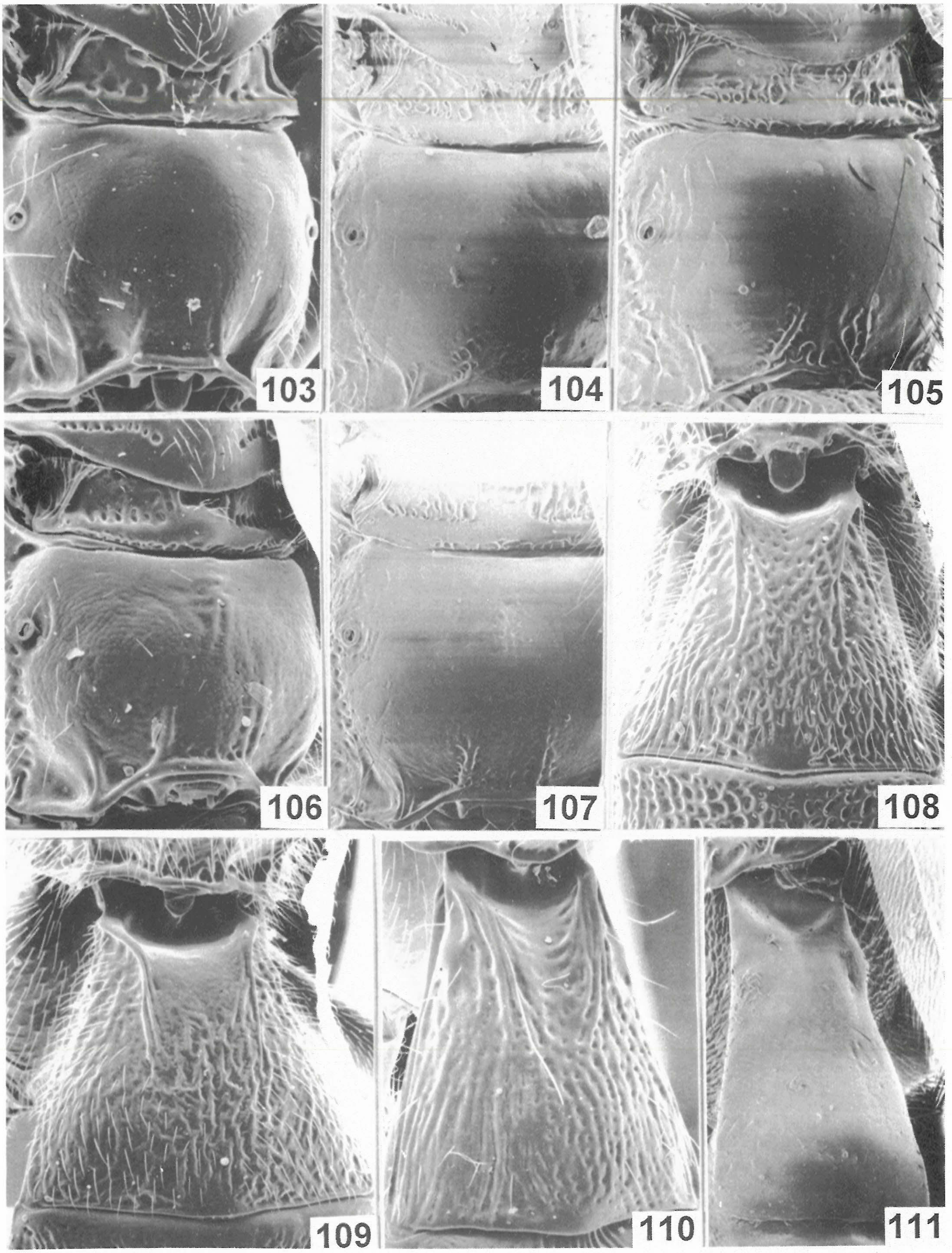
Figs. 84–85. Lateral view of pronota of *Orgilus* spp. ♀ : 84, *improcerus* sp. n.; 85, *rarus* sp. n.



Figs. 86–93. Lateral view of mesosomata of *Orgilus* spp. ♀ : 86, *cunctus* sp. n.; 87, *rarus* sp. n.; 88, *improcerus* sp. n.; 89, *galbinus* sp. n.; 90, *cretus* sp. n.; 91, *lini* sp. n.; 92, *caritus* sp. n.; 93, *meifengensis* sp. n.

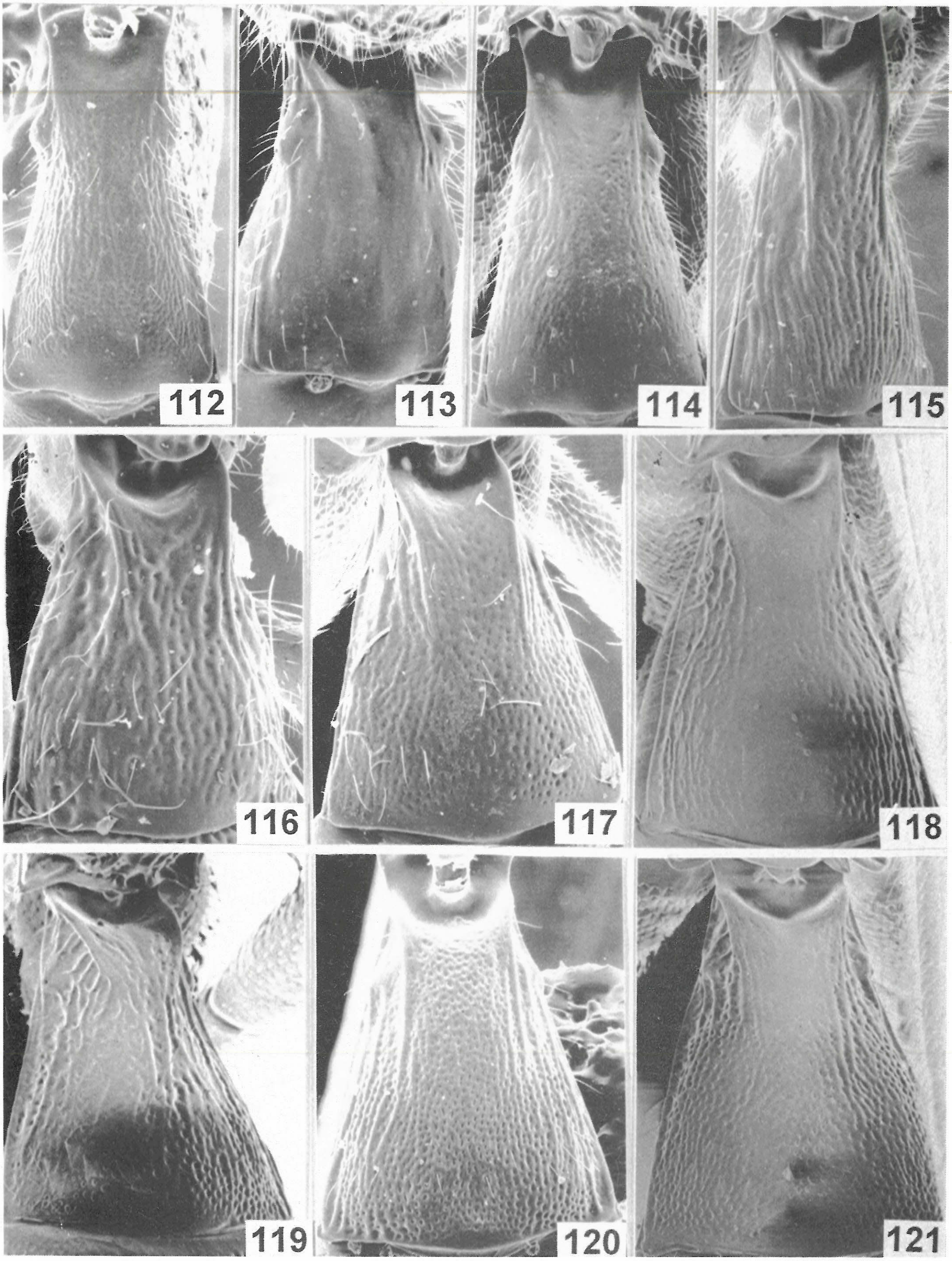


Figs. 94–102. Dorsal view of metanota and propodea of *Orgilus* spp. ♀ (except 97, 98 ♂): 94, *caballus* sp. n.; 95, *parapappianus* sp. n.; 96, *amplissimus* sp. n.; 97, *ischnus* Marshall; 98, *planus* sp. n.; 99, *taiwanensis* sp. n.; 100, *cunctus* sp. n.; 101, *improcerus* sp. n.; 102, *rarus* sp. n.

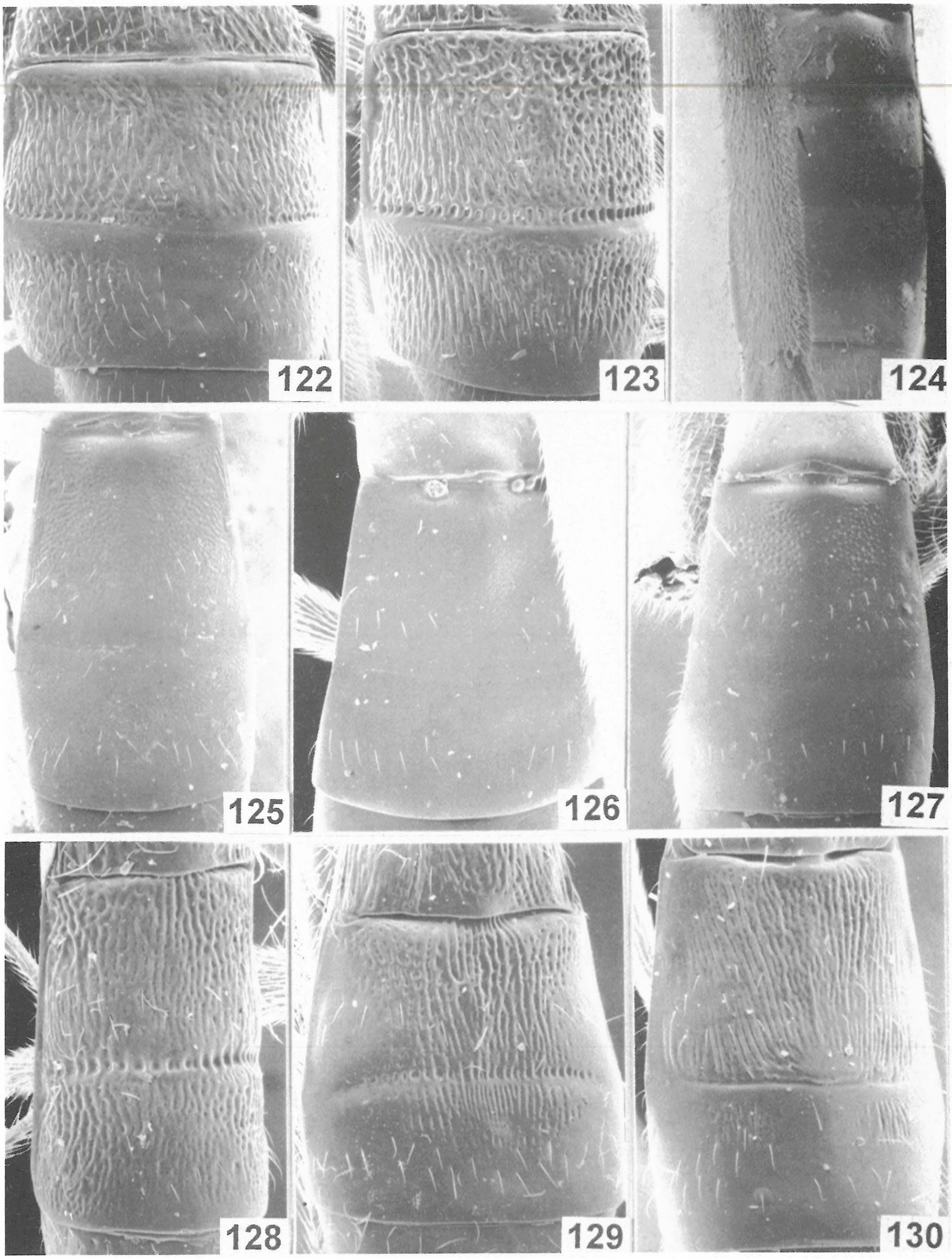


Figs. 103–107. Dorsal view of metanota and propodea of *Orgilus* spp. ♀ : 103, *galbinus* sp. n.; 104, *cretus* sp. n.; 105, *lini* sp. n.; 106, *caritus* sp. n.; 107, *meifengensis* sp. n.

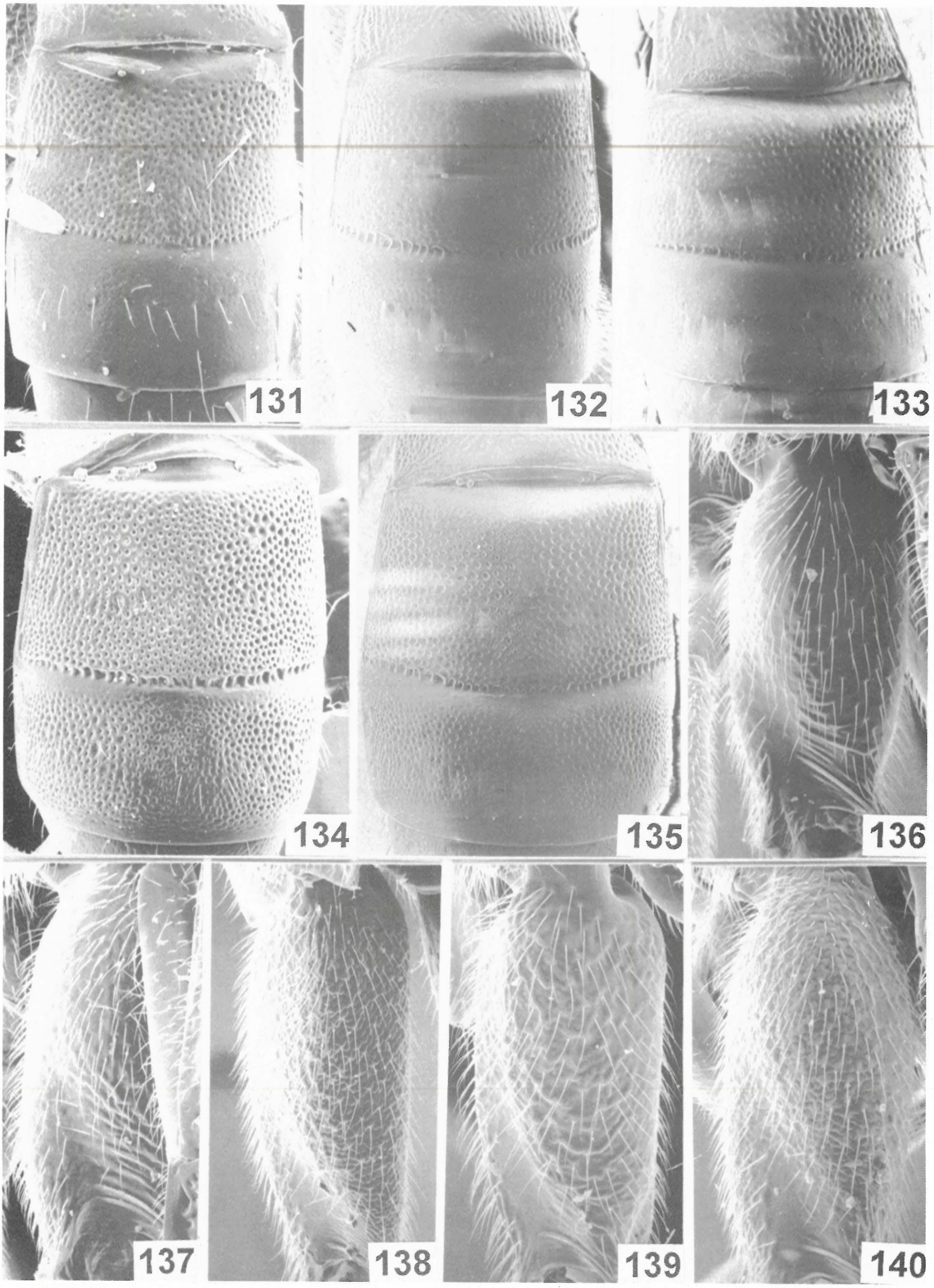
Figs. 108–111. Dorsal view of first metasomal terga of *Orgilus* spp. ♀ : 108, *parapappianus* sp. n.; 109, *caballus* sp. n.; 110, *improcerus* sp. n.; 111, *amplissimus* sp. n.



Figs. 112–121. Dorsal view of first metasomal terga of *Orgilus* spp. ♀ (except 112, 113 ♂): 112, *ischnus* Marshall, 113, *planus* sp. n.; 114, *taiwanensis* sp. n.; 115, *rarus* sp. n.; 116, *cunctus* sp. n.; 117, *galbinus* sp. n.; 118, *cretus* sp. n.; 119, *lini* sp. n.; 120, *caritus* sp. n.; 121, *meifengensis* sp. n.

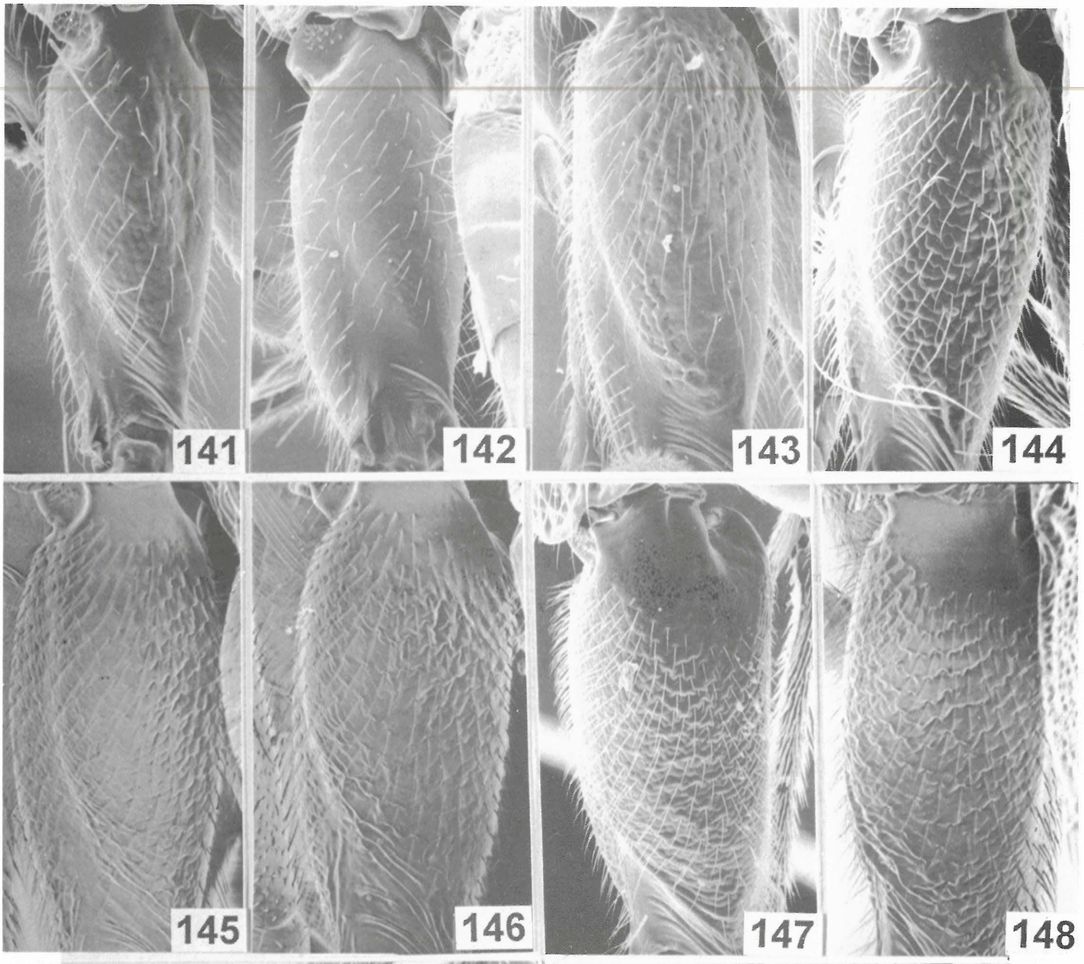


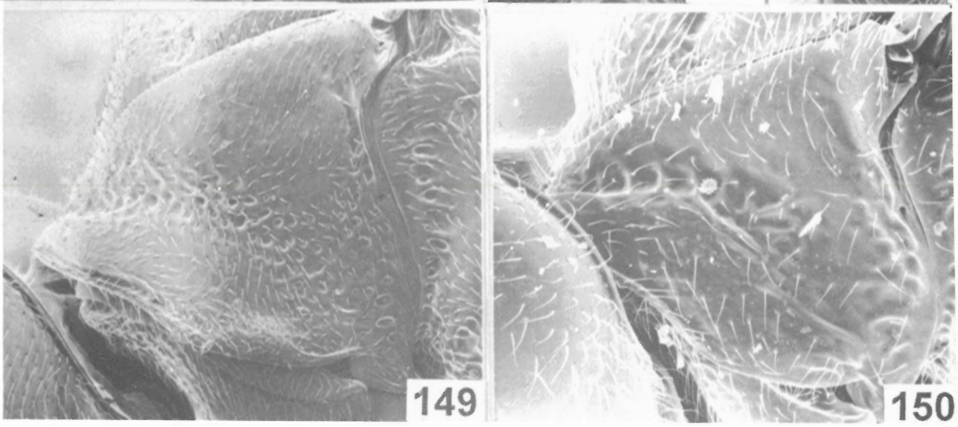
Figs. 122–130. Dorsal view of second and third metasomal terga of *Orgilus* spp. ♀ (except 125, 126♂) : 122, *caballus* sp. n.; 123, *parapappianus* sp. n.; 124, *amplissimus* sp. n.; 125, *ischnus* Marshall; 126, *planus* sp. n.; 127, *taiwanensis* sp. n.; 128, *cunctus* sp. n.; 129, *improcerus* sp. n.; 130, *rarus* sp. n.



Figs. 131–135. Dorsal view of second and third metasomal terga of *Orgilus* spp. ♀ : 131, *galbinus* sp. n.; 132, *cretus* sp. n.; 133, *lini* sp. n.; 134, *caritus* sp. n.; 135, *meifengensis* sp. n.

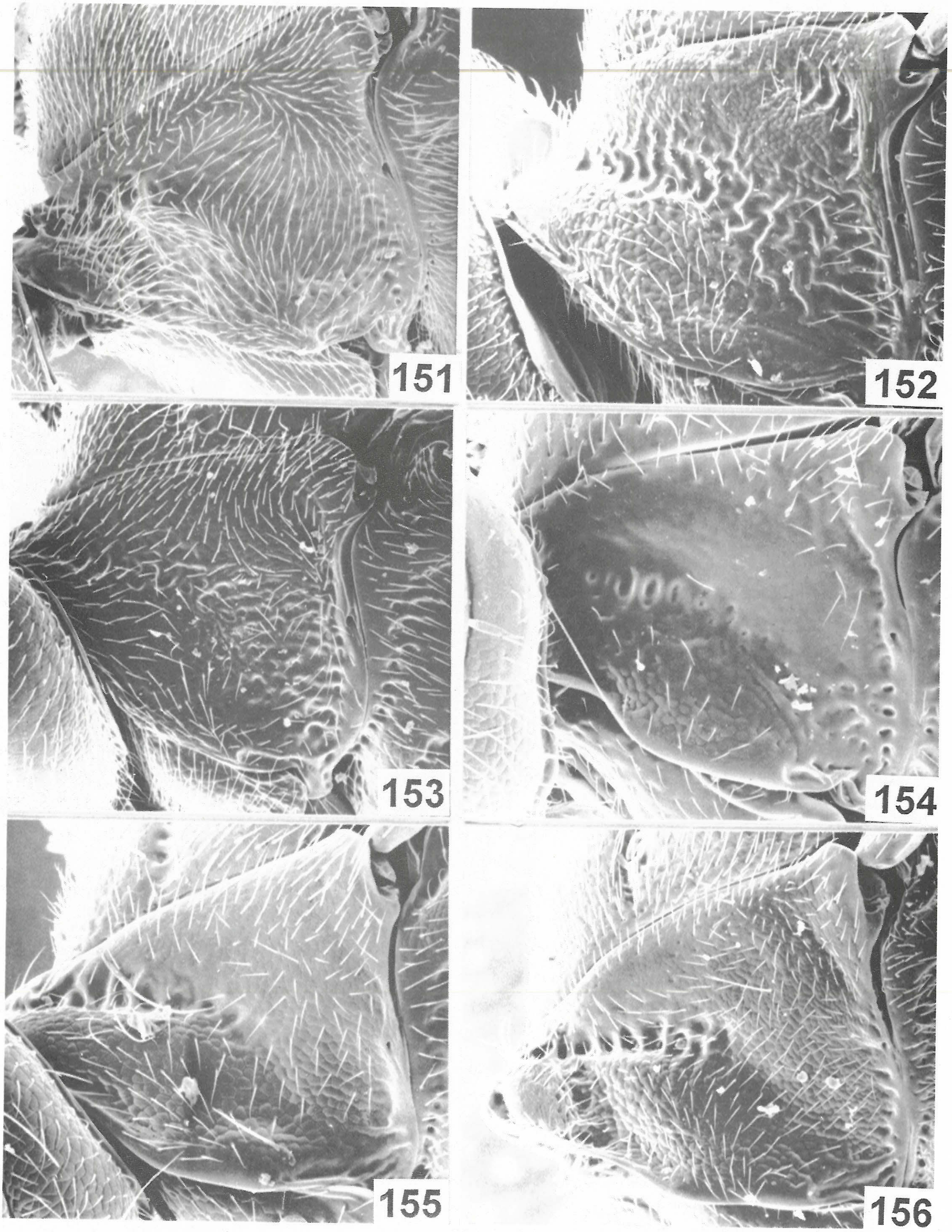
Figs. 136–140. Metacoxae of *Orgilus* spp. ♀ (except 138, 139♂) : 136, *caballus* sp. n.; 137, *parapappianus* sp. n.; 138, *ischnus* Marshall, 139, *planus* sp. n.; 140, *taiwanensis* sp. n.





Figs. 141–148. Metacoxae of *Orgilus* spp. ♀ : 141, *cunctus* sp. n.; 142, *improcerus* sp. n.; 143, *rarus* sp. n.; 144, *galbinus* sp. n.; 145, *cretus* sp. n.; 146, *lini* sp. n.; 147, *caritus* sp. n.; 148, *meifengensis* sp. n.

Figs. 149–150. Lateral view of pronota of *Orgilus* spp.: 149, *amplissimus* sp. n. ♀ ; 150, *planus* sp. n. ♂.



Figs. 151–156. Lateral view of pronota of *Orgilus* spp. ♀ (except 152♂) : 151, *caballus* sp. n.; 152, *ischnus* Marshall; 153, *taiwanensis* sp. n.; 154, *cunctus* sp. n.; 155, *galbinus* sp. n.; 156, *caritus* sp. n.

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臺灣小繭蜂科（膜翅目）之分類
V. 折脈繭蜂亞科與怒繭蜂亞科[1]

周 樑 鎰[2]

摘 要

折脈繭蜂亞科（Cardiochilinae ）與怒繭蜂亞科（Orgilinae）隸膜翅目、小繭蜂科，乃鱗翅目昆蟲之天敵。本文記錄臺灣 5 種折脈繭蜂與18種怒繭蜂；其中有14新種與 2 臺灣新記錄種。文中附分屬與種之檢索表，及形質圖。

關鍵詞：折脈繭蜂亞科、怒繭蜂亞科、小繭蜂科、分類、臺灣。

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國家作物種原資訊系統[1]

范明仁　陳　述　杜金池[2]

摘要：國家作物種原資訊系統之主要目標爲使種原中心運作電腦化，並建立國內種原資料庫，本研究報告主要目的即針對系統硬體架構、系統軟體及應用軟體作詳盡介紹。本系統應用軟體依作業功能之不同區分爲基本資料建置與轉檔、入庫、庫存管理、繁殖、分贈及引進、種原特性調查、相關資料查詢、田間資料收集、植物分類學、影像作業、區域網路監控、國外種原資訊系統連線、環境監控13個子系統。目前本系統除可與全國各農業試驗研究單位連線以提供育種者查詢本系統種原資訊外，尚可與美國 GRIN 系統連線而取得國外種原資訊。

關鍵詞：種原、資訊系統。

植物種原所具有的遺傳變異是作物品種改良的基礎，近年來世界各先進國家亦紛紛成立專責機構從事野生植物及栽培品種的蒐集、引種、保存與利用。有鑑於此，農試所全力建立「作物種原室」，負責籌辦「國家作物種原中心」，並專責辦理作物種原之蒐集、保存、利用及研究等相關業務(1)。爲使種原中心有效率、有系統的運作，建立「國家作物種原資訊系統」，將以往傳統之人工管理作業，轉化爲電腦化作業，並利用網路及整體資料庫系統作業方式，全面掌握種原資料，以達到資訊整合，並可提供國內各農業學科單位或作物專家各項種原相關資料的查詢服務，及作爲管理階層決策之參考。

本系統主要目標如下：

㈠藉用電腦化系統管理掌控種原中心的運作流程。

㈡完成目前國內各單位種原資料之建檔，並機動進行資料的隨時增輸、異動資料的更新，以維持種原資料之完整性。

㈢完成種原中心資訊網路系統，使農試所內農、園藝系及所外各農業研究單位可藉由網路或電訊相互連線，以利研究者查詢所須的種原資訊，增進種原資訊之流通與利用。此外，各相關單位亦可藉此網路將種原特性調查資料與繁殖資料直接傳輸至此系統。

㈣完成種原中心資訊管理系統與國外各種原保存資訊中心之連線，加強對國際種原資訊之了解與應用。

㈤協助國內各農業試驗單位自國內外取得所需的種原，促進種原材料之流通與交換，並擴大引種來源，以提高育種效率。

㈥訓練農業及學術界各同仁對種原中心資訊系統之認識與應用，以邁向種原共享、資訊共通的境界。

系統架構

系統架構可分爲硬體架構，系統軟體及應用軟體三方面(2)

㈠硬體架構：硬體包括資料庫伺服器、影像處理工作站、NOVELL 網路系統伺服器、個人電腦、光碟櫃、印表機、X.25路由器及網路等組成。電腦及網路系統架構詳如圖1.。

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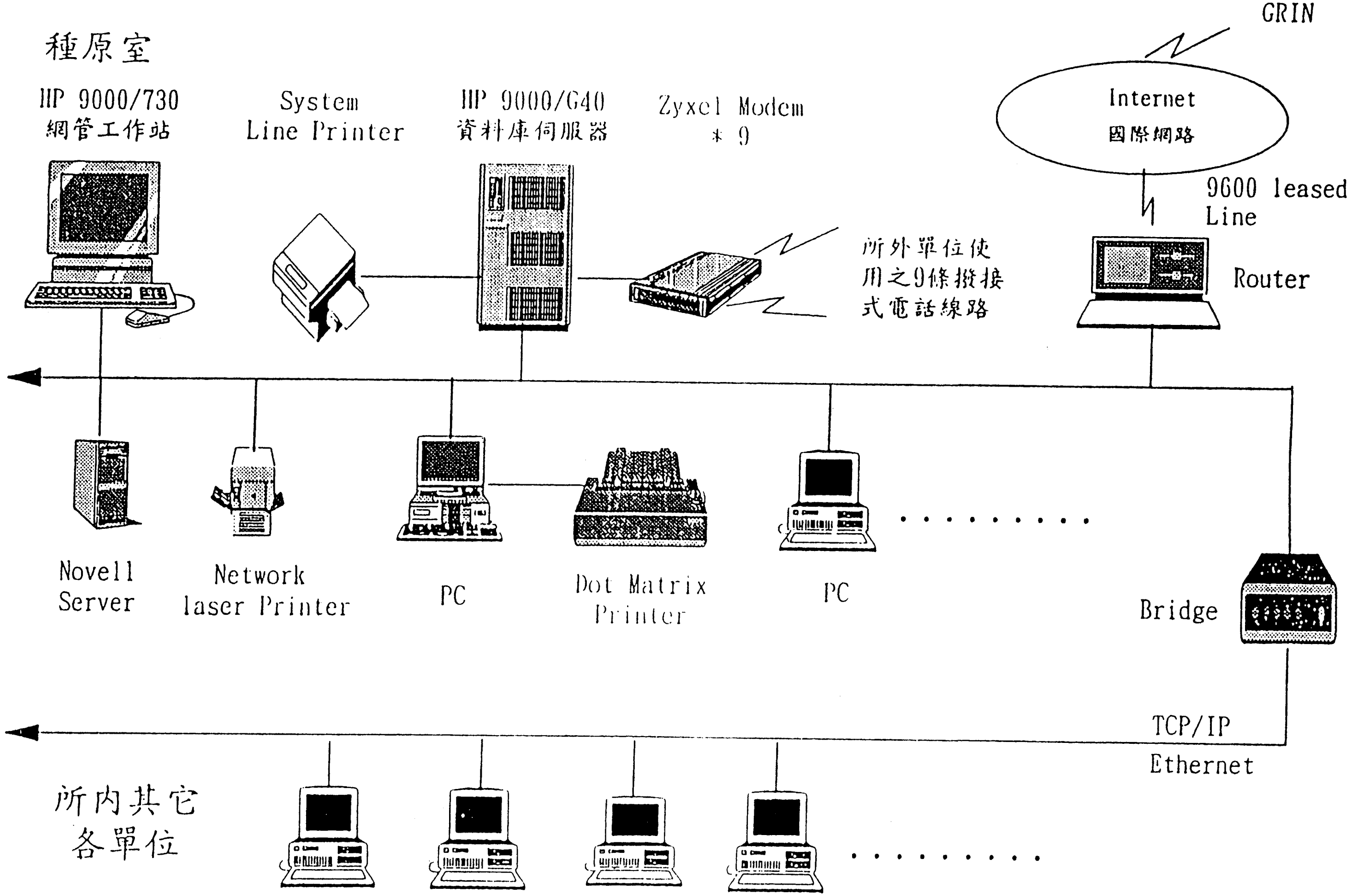

圖 1. 國家作物種原資訊系統硬體架構圖

Fig. 1. The hardware architecture of National Plant Genetic Resources Information System

其中資料庫伺服器可在 UNIX 環境下作業，並具備 MIRROR DISK 磁碟備援系統，以防止因磁碟機故障而造成的停機外，主記憶體大〔128 MB 以上〕，高磁碟機容量〔20 GB〕，傳輸速度快，I/O Bandwidth：60MB/sec 及 System Bus（CPU 至Memory）之間傳輸速度達400 MB/sec 之特性以因應種原資訊資料庫量大且查詢要快之需求[3]。NOVELL 網路系統伺服器：採512 KB 之 cache memory，可與 Netware 相容，含32 bit I/O bus 及提供10 BASET，16 bit 之 Ethernet 網路卡，並有中文卡。

(二)系統軟體：主要考量爲準確、容易使用及共容性，以便將來資訊能國際化爲原則。因此作業系統符合 UNIX SVID2，IEEE POSIX 1003.1及 X/OPEN 之 CPG3的標準，且具備磁碟鏡射功能，公用程式具備全螢幕式中英文文字編輯程式及交談式程式除錯器。通信軟體以 TCP/IP 之通信協定，且具備遠端終端機模擬，檔案傳輸，電子郵遞等功能，並具備 X.25通訊協定[4]。

資料庫管理系統：採用 ORACLE 關聯式資料庫，可支援主從架構以及多方通信能力，完全符合 ANSI 標準，可多地查詢及多地更新，提供 Redo Log 能力以便紀錄所有資料庫交易，具備 Import/Export 資料能力及支援異類資料庫等。

(三)應用系統軟體：

1. 種原中心作業流程說明[1,5]

種原中心之運作流程可分爲兩大類，其一爲材料之處理流程，另一爲資料之處理流程。就材料之處理流程而言，當一接收到新引進的種原後，立即進行檢疫並除去不良品質之種原，繼之進行增殖作業，補充種子量。接著再經"入庫儲藏流程"，包括精選、乾燥、發芽率檢測等步驟，才能將種子包裝入庫儲藏。入庫儲藏之種子必須進行發芽力檢測以確保種子活力。同時須配合政策指示或育種需要，進行特性調查評估。並應國內外學者、專家之研究需要，進行分贈交換作業。當庫存種原活力降低或儲藏量不足時，則需再進行種原增殖作業。

就資料之處理流程而言，當接收到新引進之種原後，須將來源資料以及相關資料建檔，同時比對此材料是否已經儲藏。當種原經過適當處理後準備入庫儲藏時，則須將種原材料量、發芽力檢測結果、水份含量、庫存位置等資料建檔並輸入電腦以爲庫存管理。另外如農藝性狀、特性調查及分贈交換作業之資料亦須建入種原資料庫內，以充實所收集種原之相關資料。

2. 資料庫管理

種原資料管理系統由下列各資料庫組成：

(1)基本資料庫：記錄每份材料的身份，含暫時號碼、永久號碼、名稱、原始來源、提供者、提供者國家、其它特性及蒐集資料等。

(2)特性資料庫：由特性調查及評估的資料所建立之資料庫，並可提供連線使用者特性檢索，以找出所需的材料號碼。

(3)庫存資料庫：整理並顯示每份材料的保存量、活力檢測日期、種子活力及儲存場所及位置等資料。

(4)繁殖資料庫：取得新材料時或已有材料的種子量或種子活力到達低限時，及進行特性評估等作業，進行種子繁殖時，由此資料庫安排各作物之適宜繁殖場所、期作，並依工作量及優先順序排定田間繁殖，及記錄繁殖時氣象資料及栽培管理資料以供爲種原特性調查記錄及利用時的重要訊息。

(5)分贈資料庫：記錄分贈單位、國家、捐贈者及分贈種原，以免重複分贈，以及記錄種原使用情形。

爲妥善建立及應用上述資料庫，及進行自動化之庫存管理，本系統內包含了十三支應用軟體子系統以達上述之需求，各子系統功能詳如下述，而其間之關聯如圖2. 。

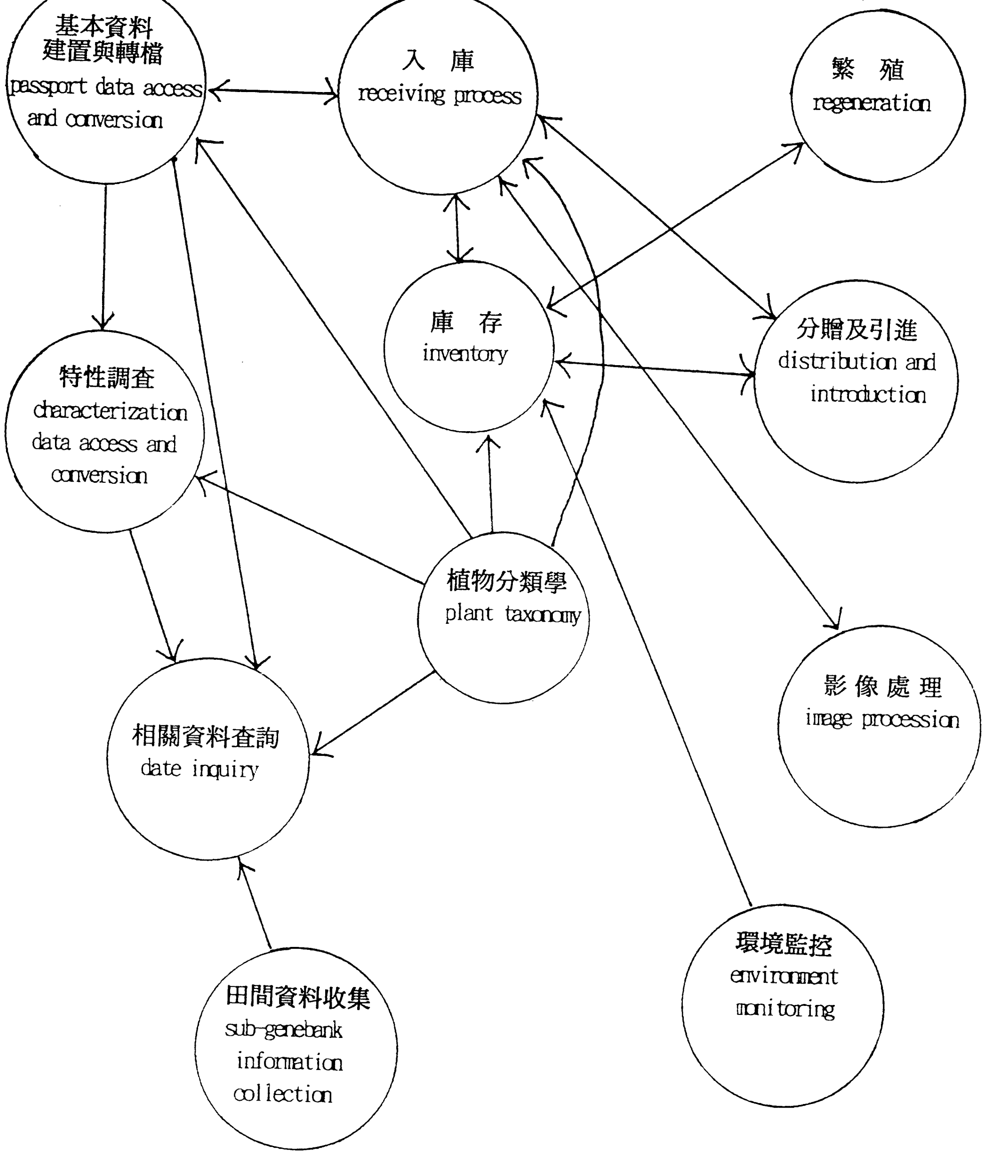

圖 2. 各 子 系 統 關 聯 圖

Fig. 2. The linkage and relationship of sub-systems in National Plant Genetic Resources Information System

1. 基本資料建置與轉檔子系統

(1)種原基本資料之建立與維護。

(2)應用轉檔程式將目前國內已有較大宗之舊有種原基本資料（如：亞蔬中心之種原資料，及農試所農藝系之水稻、玉米、大豆、落花生資料）轉檔建入本資料庫中。

(3)可依使用者需求查詢及列印種原基本資料；本系統可由查詢者輸入所欲查詢之條件（如：提供

者編號，來源國，育種歷史……等），即自動查詢出合乎於條件之種原資料並列印。

⑷可依使用者需求統計各資料檔；目前本系統可依所輸入條件，統計同一類之資料筆數。

2. 入庫子系統

⑴本系統主要功能為應用電腦化系統，配合入庫流程之進行；掌握種原入庫作業，並記錄入庫時材料狀況。本系統於入庫作業各流程均開發有輸入畫面，並可針對入庫各流程進行控制及記錄，以便隨時追蹤掌控材料之入庫作業。

⑵可與儀器設備（如：電子天平、條碼掃瞄器……等）連線，進行資料自動轉入功能：

a. 入庫作業時之臨時碼、永久碼、庫存碼等均以條碼黏貼於各份種原材料包裝上，各部門工作人員只須將條碼用條碼掃瞄器讀入即可進行資料之輸入。

b. 各入庫作業上所應用之儀器，如電動天平可與電腦連線，電動天平上之數據可用電腦直接讀取以避免人工輸入的動作及錯誤。

⑶入庫流程各種運算：如水分含量、百粒重及貯藏壽命預測公式，均已事先寫入系統程式中，各部門人員於累積足夠數據後即可直接求得結果而省去運算的動作。

3. 庫存管理子系統

⑴辦理種原材料之貯藏位置及保存量之庫存管理：針對種子儲藏庫之長、中、短期庫，組織培養保存室，無性繁殖作物保存園等，分別開發輸入畫面，可於此系統內辦理庫存管理，確實瞭解每份種原之儲存位置。

⑵可記錄並自動更新各種原保存量，以提供安全存量監控；可由入庫、繁殖、分贈及引進等子系統之資料檔中自動比對種原進出數量並進行監控之功能。

⑶可針對種原活力下降狀況進行監控，並可依指定期間提供須進行活力檢測之材料清册，並登錄活力測試結果。

⑷可提供庫存餘額、位置查詢、異動資料管制及清册之列印。

4. 繁殖子系統

⑴當種子活力降低或種子存量低於安全存量；引入新種原數量不足時，由電腦自動提出需辦理繁殖作業之種原名錄，以提醒工作人員進行繁殖作業。

⑵可依基本資料查詢及列印適宜之繁殖場所，以便工作人員選定繁殖場所、安排繁殖計畫，並列印繁殖作業需求表單，分發各繁殖場所。

⑶可針對各委託場所繁殖狀況及入庫量進行追蹤考核，並列印繁殖成果表單提報。

5. 分贈及引進子系統

⑴針對種原分贈及引進之流程進行管制以避免重複分贈及引進，並可提供分贈及引進資料之查詢及列印，於辦理種原分贈作業時，不但可結合庫存子系統檢視目前庫存種原之數量及活力，且可結合基本資料子系統，查詢材料捐贈者所備註之種原保護年限後，告知工作人員是否可分贈。

⑵可提供種原目錄及種子（苗）統計年報之編印。

6. 特性調查子系統

⑴為系統辦理種原特性資料之建立、查詢、列印及維護之程式。

⑵可依據作物別之不同，建立種原特性調查項目及該項目下特性代碼及其調查標準，並可查詢、列印及維護。

7. 相關資料查詢子系統

⑴提供各連線單位及農試所農藝系、園藝系透過數據機或由網路連線至本資訊系統主機，並利用本系統所發展之簡易查詢方式，進行種原基本及特性資料檢索查詢，查詢條件可作任何聯集交

集之運算。

(2)本系統可於載入後，提供使用者選擇中文或英文任一語言進行查詢。

(3)查詢結果可依使用者需求挑選項目列印，亦可轉成資料檔供使用者進行後續之統計分析研究。

8. 田間資料收集子系統

種原基本資料與特性調查資料有些由各育種者所提供，爲確保資料的正確性，本系統特別於個人電腦開發了與本系統植物分類學子系統、特性項目分類、特性等級區分代碼……等資料格式完全相容之終端應用軟體，協助育種者進行資料輸入之工作，此子系統主要功能即針對終端應用軟體與本系統各相關子系統間資料之傳輸與轉檔進行控制管理。

9. 植物分類學子系統

學名是辨認作物身份及分類的重要依據，但學名多源於拉丁文，複雜難記，因此特別建置本子系統，存放正確之分類學學名及作物之普通名，以便使用者可在本資訊系統內任一子系統中，藉下拉式視窗可查得正確的分類學名稱並選擇後輸入，以避免人爲輸入學名所發生之錯誤，而造成資料辨認錯誤。

10.影像作業子系統

(1)種原影像資料可協助種原重複判別，並輔助檢查經繁殖後再入庫之種原是否發生了編號與材料不符之狀況。

(2)本系統可提供種原影像資料之建立，可提供影像資料之查詢及列印，且可與基本、特性資料之文字檔相結合而出現於畫面上供使用者檢索。

11.區域網路監控作業

a. 可線上（on-line）監控內部區域網路上各部門個人電腦、工作站、主機之使用情形。

b. 線上（on-line）顯示網路節點設置狀態與線路現況。

12.國外種原資訊系統連線作業

本種原資系統可以與教育部學術網路連線，並藉該網路與美國農部種原資訊系統（GRIN）連線，可線上查詢 GRIN 系統上所有之種原資訊資料。

13.環境監控作業

可自動擷取本種原中心各主要貯藏庫及溫網室監控系統動態的溫溼度記錄，存入歷史檔以便工作人員了解庫存環境之變化。

上述有關種原庫運作電腦化管理之系統，僅限於農試所作物種原室內部使用，而有關種原資料庫建置及查詢，如『田間資料收集子系統』及『相關資料查詢子系統』則開放予各連線單位使用。目前本系統已利用區域網路與農試所原電腦系統連線，因此所內各連線單位，可透過 TCP/IP網路及網路版終端模擬軟體，即可進入本系統；而農委會及各農業試驗研究等三十餘所外單位，則可透過數據機及 RS 232版終端模擬軟體，以電話撥接方式與本系統連線，即時獲得所需之種原資訊。本系統有 9 線連線撥接電話線路，可提供各連線單位使用，各單位若欲與本系統連線，可向農試所申請使用帳號及田間資料收集子系統之系統磁片，即可進行種原資料之查詢及建置。此外，本系統並可透過 TANET 及 INTERNET 及 X.25 Local Network 軟體控制，與美國之 GRIN 系統連線而取得國際間種原資訊，以便國內育種者使用。

展　望

爲邁向種原共享、資訊共通之境界，種原資料庫之發展尙有賴各農業研究人員之共同努力，希望各連線單位能利用本系統，將各單位之種原資料鍵入，以充實種原資料庫之內容，並歡迎各研究人員充份使用本系統，查詢種原資料討論改進之處以加強種原資訊之流通，並提升本中心庫存種原之使用

效率。

誌　謝

在建立本系統過程中，尤其是硬體的選購的方面，承整建國家作物種原庫電腦審議委員會諸位委員（鄔宏潘、張德慈、曾美倉、陳嘉吉、周素珍、吳文正、郭更生、劉清）的熱誠助導，得以順利完成，特此銘註與感謝。

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National Plant Genetic Resources Information System of R.O.C[1]

Ming-Jen Fan, Shu Chen and Chin-Chyu Tu[2]

Summary

The National Plant Genetic Resources Information System (NPGRIS) is aimed to computerize the operation of the National Plant Genetic Resources Center of the R. O. C. and to build up the germplasm information database. The purpose of this paper is to introduce the hardware architecture, operational system and applications of the NPGRIS. The NPGRIS is divided into 13 sub-systems according to the different operational functions. These sub-systems include the following areas : passport data access and conversion, receiving process, inventory, regeneration, distribution and introduction, characterization data access and conversion, data inquiry, subgenebank information collection, plant taxonomy, image processing, local area network monitoring, foreign countries' germplasm information connection and environment monitoring. For interested researchers and breeders, the NPGRC provides telephone access to the NPGRIS to search for genetic resources information. Besides, the NPGRIS is also linked up with the Genetic Resources Information Netware (GRIN) in the U.S.A for querying germplasm information in the U.S. National Plant Germplasm System.

Key words : Genetic Resources, Information System.

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